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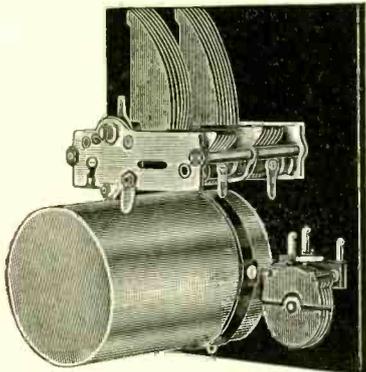
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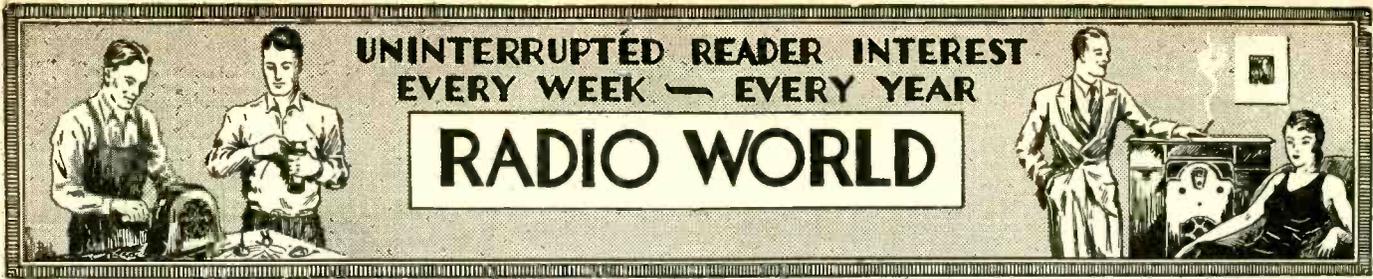
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Overall Set Testing

By J. E. Anderson

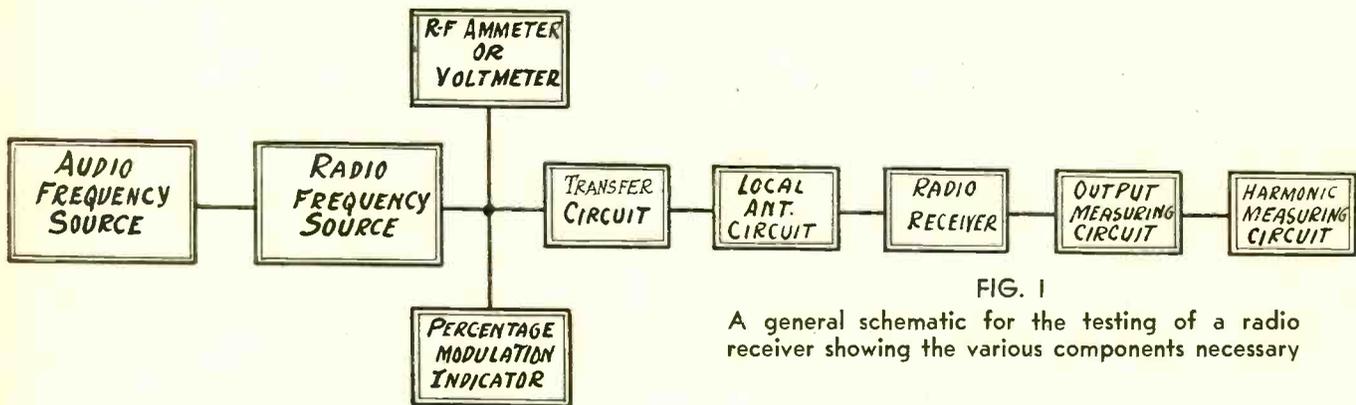


FIG. 1

A general schematic for the testing of a radio receiver showing the various components necessary

PROSPECTIVE purchasers of radio receivers always ask which receiver is the best, and they usually specify that it should be best with respect to selectivity, volume and quality. Sometimes they insist that the receiver must have 10-kilocycle selectivity and no distortion.

No one ever got a satisfactory answer to the question. At least if anybody got a satisfactory answer he did not get an honest one. The reason is that there is no answer that can be made in terms understandable to the non-technical man. Moreover, there is no best receiver. A given receiver may be poor from one engineer's point of view and very good from another's point of view. Yet these engineers may have the same data from which to base their opinions and may be equally competent to judge. Both agree, perhaps, as to what the characteristics of the ideal receiver should be, and if that receiver could be produced they would both pronounce it the best.

As long as perfection cannot be attained they will differ because they will place different weights on the different characteristics of a receiver. One may give more weight to selectivity and less to sensitivity while another will give more weight to sensitivity and less to selectivity. Then again, they may differ honestly about quality. For example, one may consider that full volume at 5,000 cycles per second is quite satisfactory while another will insist that full volume should go as high as 10,000 cycles. Again, they may differ about the response at the bass end of the scale.

Great Expectations

Engineers who know radio are not looking for perfection in a radio receiver, but they may be looking toward it and may be striving for it. The fans expect perfection in every characteristic, but they are usually satisfied much more easily than the engineers. The fan expects 10 kc selectivity. To the engineer such selectivity is a fiction. The fan expects sensitivity that will bring in stations from every point of the earth, day or night, Winter or Summer. To the engineer such sensitivity is utterly impractical. The fan expects volume enough to cause the loud-speaker to execute a jig and make all objects in the room start wiggling in sympathy. The engineer has to look to costs of such volume.

A receiver has many characteristics which must be measured, but they are so complex and varied that they cannot be expressed by a single figure of merit. Each characteristic must be expressed in its own way, and that way is usually a curve, or a

set of curves. The answer to the question, "Which receiver is best?" is contained in all these curves and figures.

The corresponding curves, or figures for all the receivers should be compared. Only then it is possible to say which is best with respect to some particular characteristic. Comparing selectivity curves, we can say which is the most selective. Comparing sensitivity curves, we can say which is the most sensitive. And similarly we can say which has the least hum, the most realistic quality, the greatest undistorted output, and so on. But chances are that no one receiver will take first place in any two characteristics. Hence we must either conclude that no one is best or that they are all good or bad.

One of the receivers may be the best compromise among the many conflicting characteristics, but which is the best compromise depends on the relative importance the judge places on the various characteristics. That is the reason engineers differ, and the sets differ because the engineers differ, because the characteristics of any particular receiver are about what the designing engineer meant they should be.

Standardization

The Institute of Radio Engineers has outlined certain tests of receivers which will yield characteristics by which different receivers may be compared intelligently. These tests include sensitivity, power output, percentage distortion, hum content in the output, fidelity, and others. The standardization is not exact, because the complexity of the subject does not admit exactness. It amounts to practically nothing else than an agreement of how to interpret the properties of a receiver. Certain figures are accepted as standard merely to form the basis of a quantitative comparison of different receivers.

The definitions of the various properties form an important part. Thus sensitivity of a radio receiver is defined as "that characteristic of the radio receiver which determines to how weak a signal it is capable of responding." It is "measured quantitatively in terms of the input voltage required to give a standard output."

Selectivity of a radio receiver is defined as "the degree to which the radio receiver is capable of differentiating between the desired signal and signals of other carrier frequencies." This characteristic "is not expressible by a single numerical value, but requires one or more graphs for its expression."

(Continued on next page)

Determination of Sele

Standard Proposed for Comparison of Receivers

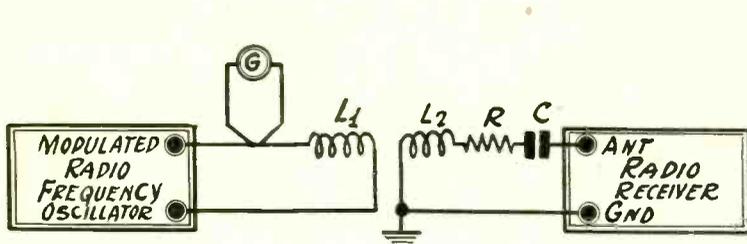


Fig. 2

The transfer circuit and artificial standard antenna for measuring the input to a receiver under test.

(Continued from preceding page)

"The fidelity of a radio receiver is the degree to which the radio receiver accurately reproduces at its output the form of the signal which is impressed upon it. The fidelity of a radio receiver is measured by the accuracy of reproduction, at the output terminals, of the modulation of the radio wave."

Normal Test Output

Normal test output of a receiver is an audio frequency power of 0.05 watt in a non-inductive resistance at the output terminals of the receiver, carrying AC only, when the resistance has been adjusted to that value which the manufacturer of the tube recommends for greatest undistorted output.

Normal radio input voltage for testing purposes is the root-mean-square voltage of the signal received, modulated at 30 per cent. at 400 cycles per second which results in normal test output at resonance. If the radio receiver includes a self-contained antenna, then the signal is to be impressed on a real or artificial antenna.

As applied to the testing of a broadcast radio receiver not having a self-contained antenna, the standard antenna, real or artificial, is one having a series capacity of 200 micro-microfarads, a self-inductance of 20 microhenries, and a resistance of 25 ohms.

The five standard test frequencies in the broadcast band are 600, 800, 1,000, 1,200 and 1,400 kc. When tests are made at only three points, the values 600, 1,000 and 1,400 kc are used.

Schematic Arrangement of Test Circuit

In Fig. 1 is a schematic of the various circuits required in testing receivers. At the extreme left we have the audio frequency source which may be a mechanical, electrical or beat oscillator. This feeds into the source of radio frequency, the second rectangle. That means that the audio frequency oscillator modulates the radio frequency oscillator output. The radio frequency oscillator may be any one of a number of different oscillators covering the broadcast band. It should be provided with a device for changing the frequency by known amounts off resonance. That is to say, there should be a vernier attached to the tuned circuit which is calibrated in kilocycles.

After the radio frequency oscillator are two meters, one which measures the output of the radio frequency oscillator and another which measures the degree of modulation. There should be a device attached to the audio oscillator by means of which the degree of modulation may be varied.

The transfer circuit is some kind of attenuator. One type available consists of series and shunt non-inductive resistances which may be changed in value so that for a given input any desired lower output may be obtained. A small known resistance, say one ohm, of the final resistance of this attenuator is connected in series with the real or artificial standard antenna. If the current through this small resistance is known, the input voltage to the set is also known, and the current is known by

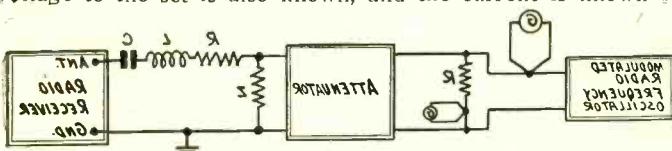


Fig. 4

A transfer circuit between the modulated radio frequency source and the receiver under test. The voltage put into the attenuator is measured and the known attenuated voltage is impressed in series with the standard antenna by means of impedance Z.

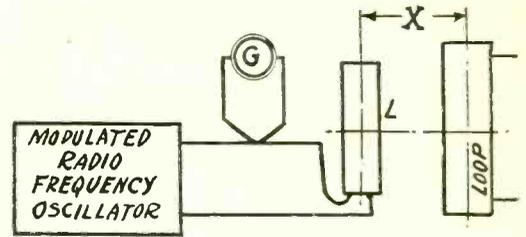


Fig. 3

A transfer circuit for use when the receiver under test is provided with a loop antenna. The current in L is measured and the voltage induced in the loop is calculated.

measurement ahead of the attenuator and by the known attenuation.

Output Measuring Circuit

The output measuring circuit following the receiver under test is usually a vacuum tube voltmeter, and it is connected to the terminals intended for the loudspeaker, across which a non-inductive resistance equal to the load resistance recommended by the tube maker for that tube is connected. Normal test output power is obtained when the root mean square voltage read on this meter is equal to the square root of .05R. If the output tube is a 171A, for example, the value of R is 4,000 ohms and the output voltage for standard test output is 14.14 volts.

The harmonic measuring circuit is a device by which the total distortion in the output is measured, usually when the tube is delivering so-called maximum undistorted power output. There are many different circuit arrangements by which the harmonics may be measured. In one a high pass filter is used with a cut-off between the first and the second harmonics. The fundamental, or first harmonic, is therefore suppressed and all the undesired harmonics are transmitted to be measured with a thermal or other type of AC instrument.

Details of Transfer Circuits

Fig. 2 shows the details of one type of transfer circuit. L1 and L2 are the primary and secondary of a radio frequency transformer, L2 being the 20 microhenry inductance of the standard antenna and L1 a load coil on the modulated radio frequency oscillator. Only alternating current should flow in L1 because the current is measured with a thermocouple type AC meter G and this would measure the DC component as well if it were present. L1 and L2 should be a calibrated variocoupler so that for any degree of coupling between them the voltage induced in L2 is known when the current in L1 is known.

When the mutual inductance between L1 and L2 is known for every setting of the coupling the voltage induced in the secondary is related to the current in the primary by the relation $E_2 = MwI_1$, in which M is the mutual inductance expressed in henries, w is 6.2832 times the frequency of the current, and I1 is the primary current. If I1 is measured in effective values, as it will be with a thermocouple type meter G, the voltage E2 is also given in effective values. The above simple relation assumes that the coupling is loose at all settings used.

Receiver with Loop

When the radio receiver is provided with a loop, the transfer circuit in Fig. 3 is recommended. The voltage induced in the loop by this method must be calculated from the formula:

$E = .396N_2N_1hsfA^2I/B^2$, in which E is the voltage in microvolts induced in the loop, N1 is the number of turns on the coil L, N2 the number of turns in the loop, h the height of the loop in meters, s the length of the loop in meters, f the frequency of the current in kilocycles, A the radius of coil L in centimeters, I the current in L in microamperes, and B is a quantity defined by B equals the square root of $A^2 + X^2$, in which X is the distance in centimeters as indicated in Fig. 3.

This formula holds if the distance is small compared with the

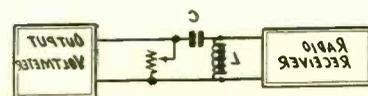


Fig. 5

An output circuit for use in measuring output when the receiver is not provided with an output filter.

Activity and Fidelity

Under Test Circuits for Measurements

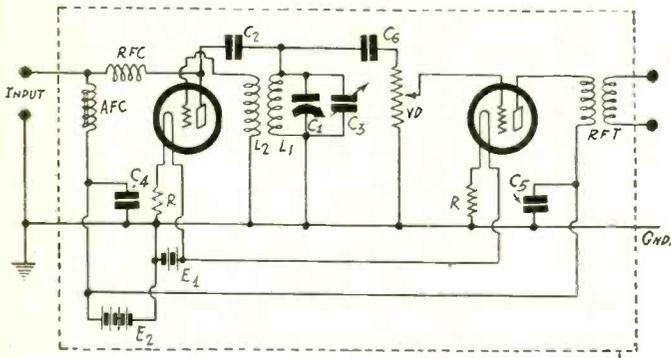


Fig. 6

A modulated radio frequency oscillator and a stage of radio frequency amplification the output of which may be varied. The audio signal is impressed at the input terminals.

length of the wave used, which is usually the case for broadcast receivers. Another condition is that the planes of the coil and the loop be parallel and that they be placed so that the center lines coincide.

Let us apply this formula to a special case. Let N_1 and N_2 be 40 and 20 turns, respectively, h and s each one meter (39.37 inches), f , 1,000 kilocycles; A , 3.81 centimeters (1.5 inches), I , 10,000 microamperes (10 milliamperes), and X 50.8 centimeters (20 inches). These values make B 51, very nearly. Substituting all the values in the formula, we obtain 346,000 microvolts. This number decreases rapidly as the distance X is increased. It also decreases rapidly as the radius of the coil L is decreased. If X be made very large compared with A , B may be written equal to X without committing an appreciable error.

Impedance Coupling Input

When the input is coupled to the receiver by means of an impedance, the circuit in Fig. 4 may be used. In this case R , L and C are the values of the standard antenna and X is a small coupling impedance, which may be a pure resistance of small value. The attenuator may be calibrated either in current or in voltage. The formulas for these cases are very simple. In case the calibration is by current the voltage impressed on the receiver is $E = KZI$, in which E is measured in microvolts, Z in ohms, and I in microamperes. K is the attenuation factor of the attenuator. The current I is measured with the thermo-couple meter G in series with the line from the modulated oscillator, no current to flow through the shunt resistance R .

If the attenuator is calibrated in volts the formula is $E = Ke$, in which E is the voltage across Z in microvolts, K the attenuation factor of the attenuation network, and e is the input voltage in microvolts. This voltage e is measured with the meter in series with the resistance R and the value of R . That is, the milliammeter measures the current through R and the product of the resistance and the current is the voltage e . The lower thermocouple meter G may be calibrated directly in volts, or microvolts, for a fixed value of R .

Output Measurements

In Fig. 5 is shown the arrangement for measuring the audio frequency output of a radio receiver when the output circuit carries DC as well as AC. A high inductance choke L is connected in place of the loudspeaker. This choke should have such high impedance that it does not carry any appreciable AC. The AC is taken off through a large condenser, which should have such high capacity that its impedance to the lowest frequency to be measured is inappreciable or negligible. Since the test frequency is 400 cycles per second, the impedance of a 4 mfd. condenser is only about 100 ohms, which is small compared with the value of load resistance which is connected in series with it, although a value of 8 mfd. is frequently recommended. To measure the output the resistance of the rheostat is adjusted to have the value of the recommended load resistance for the tube in the circuit, and the voltage drop in this is measured with the vacuum tube voltmeter. The input voltage to the receiver should be adjusted until the voltmeter reads a value equal to the square root of $0.05R$, where R is the resistance of the rheostat adjusted to the value cited above. This is for standard test output.

Many radio receivers have the choke L and the condenser C built in. In such cases the voltmeter may be connected directly to the output terminals of the receiver.

In case the last stage of the circuit is push-pull with direct

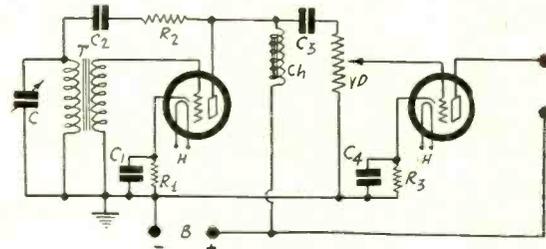


Fig. 7

A typical audio frequency oscillator with a stage of amplification and a volume control for varying the input to the radio frequency oscillator.

coupling between the speaker and the tubes, the voltmeter may be connected from plate to plate without any condensers in series, provided that the vacuum tube voltmeter has no other connection in common with the receiver, such as ground, for example. The value of the load resistance in this case should be twice the value for a single tube.

Transformer Output

When the receiver is provided with an output transformer, the vacuum tube voltmeter should be connected across the secondary in shunt with a resistance determined by the relation $R_s = R/A^2$, in which R is the resistance recommended for use with the tube to give maximum undistorted output, A is the ratio of the primary to secondary turns of the transformer, and R_s is the actual resistance connected across the output terminals of the transformer. In case of push-pull R should have twice the value used for a single tube.

As an example, suppose we have an output stage using two 245 tubes in push-pull with a step-down transformer having a ratio of 30. The value of R in this case should be twice 1,900 ohms, or 3,800 ohms. The value of A is 30. Hence R_s should have a value equal to $3,800/900$ ohms, or 4.22 ohms. The vacuum tube voltmeter in this case will read a very low voltage when standard test output is obtained. In this particular example the voltage across the 4.22 ohm resistance will only be 0.46 volt.

Modulated Radio Frequency Oscillator

In Fig. 6 is the circuit of a modulated radio frequency oscillator with a stage of radio frequency amplification provided with a voltage divider VD for controlling the output. The input terminals in this circuit are for audio frequencies generated by an external source. AFC is an audio frequency choke of not less than 30 henries and RFC is a radio frequency choke of about 85 millihenries. C_2 may be a condenser of about 500 mmfd. The plate circuit coil L_1 is tuned with a large variable condenser C_1 of 500 mmfd. and a small variable condenser C_3 . The tuned circuit should be calibrated in kilocycles for a given position of C_3 so that when this condenser is set at this index position the frequency generated by the circuit is known by the setting of C_1 . It is desirable to set C_3 so that for any given position of C_1 the frequency of the circuit may be both increased and decreased with C_3 by a definite number of kilocycles. That is, the condenser C_3 should be calibrated in kilocycles off resonance both above and below. Since the calibration will be different for different settings of C_1 , calibrations might be prepared for each of the standard test frequencies. C_3 should preferably be of the straight line capacity type.

Suppose the total capacity of C_3 is 50 mmfd. and C_1 is 500 mmfd. Then when C_1 is set at maximum and C_3 at middle, the total capacity in the circuit is 525 mmfd. If the inductance of the coil L_1 is such that this tunes the circuit to 550 kc, the small condenser will reduce the frequency by 12.5 kilocycles and it will increase it by about the same amount. At the other end of the broadcast band the effect of the trimmer will be very much greater.

Coil Data

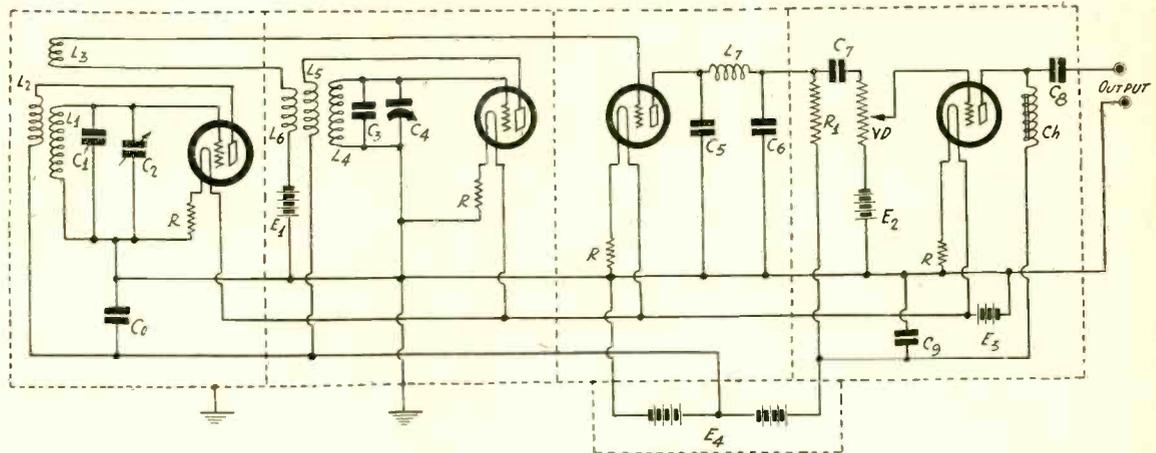
L_1 and L_2 may be wound on a 1.75 inch circular form with No. 28 enameled wire. L_1 , the tuned winding should then contain 57 turns. L_2 may contain the same number of turns of the wire.

If the two tubes in the circuit are 201A the ballast resistors R should be 4 ohms each for a filament battery (E_1) of 6 volts. If the plate voltage (E_2) is not very great, it is not necessary to provide more bias than that supplied by the ballast resistors. For low output 45 volts will do. However, if it is desired to get a greater output, a 171A tube may be used in the amplifier stage,

(Continued on next page)

Percentage Modulation and Science Proceeds Toward a Determination of

Fig. 8
A beat frequency type of audio generator comprising two radio frequency oscillators, a detector, and a stage of audio frequency amplification. A volume control is provided.



(Continued from preceding page)
in which case the plate voltage on that tube may be raised to 180 with a grid bias of 40.5 volts. This may be supplied in series with the low end of the voltage divider. C6, capacity .0005 mfd., is connected in the circuit so that no current will flow in case the higher bias is used.

RFT is a radio frequency transformer for coupling the output of the modulated oscillator to the transformer circuit and the radio receiver under test.

The oscillator as a whole should be inclosed in a grounded metal box to prevent radiation from the coil and the wiring.

Audio Oscillator

Fig. 7 gives a typical audio frequency oscillator circuit together with an output amplifier. T is an iron core transformer of suitable inductance and a ratio of turns equal to unity. C is a variable condenser by means of which the plate winding of the transformer is tuned. C2 is a stopping condenser of 2 mfd. or more and R2 is a resistance the object of which is to prevent excessive regeneration and hence to prevent excessive harmonics in the output. R2 also helps to stabilize the frequency.

The value of R2 depends on so many factors that it cannot be stated definitely. However, a resistance of 10,000 ohms should permit oscillation at all audio frequencies.

One transformer will not cover the entire audio frequency band from 25 to 10,000 cycles. About three transformers of different inductance are needed. While one could be made to cover the band if the range of the condenser C were large enough, the oscillation usually stops when the capacity becomes large, and the calibration does not mean anything when the capacity becomes very small.

In one oscillator of this type the inductance of the largest coil was 26 henries, which required a capacity of about 10 mfd. to tune to 100 cycles per second. Two other and smaller coils were necessary in this oscillator to cover the band up to 10,000 cycles. When only a small range of frequencies is desired an audio output transformer can be used for T, and the condenser C may be connected either across the primary or the secondary. Since the windings are different the frequency ranges will also be different for a given range of capacity. An output transformer is suggested because the inductances of the windings are low so that fairly high frequencies will be obtained. An ordinary audio frequency coupling transformer will usually give too low frequencies even when no condenser is used across either winding.

The disadvantage of an oscillator like that in Fig. 7 is that a very large condenser is needed, a condenser made up of many fixed condensers of various capacities and a variable air condenser with a capacity somewhat larger than the smallest fixed condenser. If an oscillator of this type is to cover the entire audio band it is likely to be expensive.

Constants of the Circuit

If the tubes in Fig. 7 are 227s the values of the components may be as follows: C2, 2 mfd.; C3, 2 mfd.; R2, 10,000 ohms; Ch, a 100 henry choke; C1 and C4, each 4 mfd.; R1 and R3, each 2,000 ohms; VD, a half megohm voltage divider. The plate voltage might be from 135 or 180 volts. The heater voltage at H, of course, should be 2.5 volts.

While R2 is listed as 10,000 ohms, a higher or a lower value should be used as required. If it is zero the oscillation will be intense but the output will be very rich in harmonics and will not be suitable for many measurements. If R2 is large the circuit may not oscillate for some settings of the tuning con-

denser, but when there is oscillation the output will be practically free from harmonics. The oscillation then will be feeble and that is one reason the amplifier is used. If the circuit is calibrated for one value of R2, the calibration will not hold for any other value.

It is important that the voltage divider be such that the slider may be moved practically to the ground. In many voltage dividers there is considerable resistance left when the slider has been moved as far as it will go so that the output cannot be reduced as much as required in many instances. There are voltage dividers with tapered resistance elements which work out satisfactorily.

Beat Note Oscillator

One of the most satisfactory sources of audio frequencies is a beat note oscillator. While this requires many tubes and thorough shielding of the elements it can usually be built at a smaller cost than one like that shown in Fig. 7 because no expensive coils and condensers are needed. Moreover, with a single vernier condenser it is possible to cover the entire audio band of frequencies. Again, it is capable of giving a relatively pure output note at any frequency.

While the frequency will change easily it is not difficult to restore the calibration for it may be done by trimming one circuit at one frequency. Two radio frequency oscillators are needed in the beat note oscillator and if these two are made similar, if the frequency of one changes by a certain amount the frequency of the other will change in the same direction by approximately the same amount so that there is relatively little change between them, which means that there is little change in the beat note.

The circuit of one beat note oscillator is shown in Fig. 8. There are four tubes and associated circuits and one shielded compartment for each. The first two tubes are radio frequency oscillators, the third tube is a detector and the fourth an audio frequency amplifier. The use of one detector and one audio amplifier tends to eliminate some of the distortion or harmonics because the amplifier corrects for distortion in the detector.

The two radio frequency oscillators are exactly the same as far as the circuits go, the only difference between in the trimmer condensers C2 and C4. The oscillator system of each contains three windings, ticklers L2 and L5, tuned windings, L1 and L4, and pick-up windings L3 and L6.

One of these oscillators generates a fixed frequency of about 200,000 kc. The other oscillator generates the same frequency when the trimmer condenser is open, but when the trimmer is closed it generates a frequency of about 10,000 cycles lower, that is, 190,000 cycles. Thus there is a change in the beat note from zero to 10,000 cycles as the trimmer condenser is moved from one extreme to the other.

Let us assume that the first oscillator is the one of fixed frequency. The frequency is adjusted by adjusting the turns on L1, the capacity of C1, and that of C2 until it has the desired value. C2 is a regular trimmer condenser by means of which the frequency may be varied by small amounts for the purpose of restoring the calibration. This will be discussed later.

The Variable Oscillator

The second RF oscillator, then, is the one that is to be variable from about 190,000 to 200,000 cycles. Let us assume that C3, the fixed condenser, has a capacity of about 500 mmd. and that C4 has a capacity range of 50 mmd. Actually C3 will be a little higher because if the condenser used has this value the distributed capacity and the minimum capacity of C4 must be added to it. We might assume that it actually has a capacity of 550

Harmonic Content Measured

Accepted Values for Comparison of Receivers

mmfd. With these assumptions we can determine what the frequency of the oscillator should be in order that C4 should cause a change of 10,000 cycles as it is changed the 50 mmfd. We find that it should be about 235,000 cycles. This can easily be attained by changing the turns on the tuned coil. Of course, another variable condenser may be used for C4, in which case the frequency would have to be different, but in any case it is always possible to get the trimmer C4 to cover 10,000 cycles by changing C3 or L4. It should be stated that it is not necessary that the trimmer should cover just 10,000 cycles. If it covers a little more or a little less it makes no difference. Hence the adjustment is not critical.

A good way of judging when the variation due to C4 is about right is to vary the beat from zero just to inaudibility. The highest frequency that can be heard by an average individual is somewhere between 10,000 and 15,000 cycles.

Making the Adjustment

First set C4 at zero and then adjust the frequency of the first oscillator until zero beat is obtained with the second oscillator. This variation of the frequency of the first may be made, as was suggested by adjusting C1, the turns on L1, or the setting of C2. When zero beat has been obtained, turn C4 to maximum. The beat note should become inaudible at or near the maximum setting. If the beat note becomes too high long before the maximum setting, the frequency of both oscillators is too high. If the beat note at maximum of C4 is not high enough, the frequency of both oscillators is not high enough. It is safer to have the frequency of both too low to start with than too high, for it can easily be increased by removing turns from L1 and L4.

Suppose now that we have adjusted the frequencies of both oscillators to the proper values, or to satisfactory values, as determined by the frequency change due to a complete change of C4, we are then ready to calibrate the beat note oscillator, and by calibration is meant determining the audio frequency at every setting of the dial of condenser C4. This should be a large dial so that it may be read accurately. Moreover, the dial should be rigidly attached to the condenser so that it cannot slip, for any slippage would upset the calibration. As a help to prevent this occurrence there should be no stops on the condenser. This practically limits C4 to the straight line capacity type. This type of condenser will yield a calibration curve which is very nearly straight line frequency. It will be straight except at the higher beat frequencies. Hence this type of condenser is preferred for two major reasons.

Calibration

The calibration may be done against another calibrated oscillator, against a series of tuning forks of known frequencies, or against a piano in tune, or again, it can be done against the 60 cycle hum in a power line. The simplest of these is another calibrated oscillator, for forks and pianos don't go as high as this beat note oscillator is to be calibrated. The piano goes to a little over 4,000 cycles and forks can be obtained which go to about the same value. It is always possible to go higher by using harmonics or sound beats. For example, if the highest known frequency available is 4,000 cycles, it is easy to go to 8,000 by sounding the two simultaneously and adjusting C4 until the 8,000 cycle note generated by the oscillator produces zero beat with the 4,000 cycles. It is even possible to go to 12,000 cycles that way.

If the 60 cycle note from a power line is used harmonics and sub-harmonics will have to be used throughout. This offers no difficulties down to 30 cycles or up to about 300 cycles. To go higher it may be necessary to set up an auxiliary oscillator tuned to about 300 cycles and then using the harmonics of that, which should bring the calibration up to at least 1,500 cycles, in steps of 300 cycles. By the same process the frequency may be stepped up to the upper audible limit, or to the limit of the beat note oscillator. It is not necessary to have known frequencies corresponding to every division of the dial of C4. About every 10 is sufficient. But points should be determined near the limits. After the dial settings for many known frequencies have been found, a curve should be plotted with frequency against dial settings. This curve will fill in all the missing points. Moreover, extreme accuracy is not necessary.

Restoring Calibration

It may be that the calibration will shift with change of tubes, change of voltage on the filament and the plates, or simply with time. The calibration may be done one day and the next is may not be trustworthy. This difficulty is one reason for the use of C2 in the first radio frequency oscillator. By a slight readjustment of it the calibration can be restored. To do this C4 is adjusted to the dial setting that should yield some known low

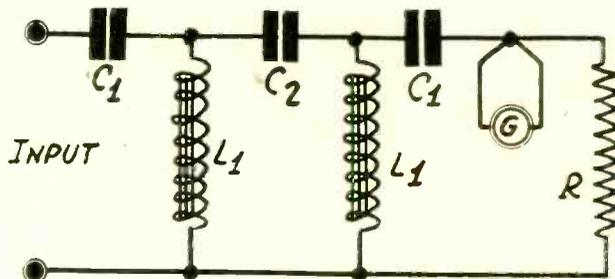


Fig. 9

A high pass filter of two sections, with mid-series termination, for use in suppressing the fundamental when the harmonic content is to be measured.

audio frequency. Then C2 is adjusted until this note is produced. The calibration is then good throughout the scale for all practical purposes. A low frequency is recommended for two reasons. First, such a frequency is always available, and second, if the restoration is done at a low frequency it is more reliable throughout. Obviously, the best frequency to use in this restoration work is the 60 cycle line frequency. This check-up of the calibration should be done every time the oscillator is put in use. It will only take a few minutes.

It is best to use batteries throughout in the oscillator for they are more steady than AC operated substitutes. Since batteries are used the 60-cycle test frequency is not directly present. But it may be introduced into the speaker with a small transformer such as a filament transformer, in which case the low voltage winding should be connected in series with the speaker connected to the beat note oscillator. Another way is to use a headset, connecting that to the transformer secondary. By listening with one ear to the headset and with the other to the output of the beat notes oscillator equality of frequency can easily be established. In case the beat note oscillator is used where there is no 60-cycle current, or any other frequency, a tuning fork of low frequency can be used.

The control for condenser C2 should be such that it will not be displaced accidentally or by jars. It should turn stiffly or there should be a locking device on it.

The Detector

The detector is simply a tube operated with high negative bias. Two small coils L3 and L6 pick up radio frequency voltages from the oscillators and impress them in series on the tube. The output is the beat note, an audio frequency. It is coupled to the amplifier by means of resistance-capacity. R1 should be about 100,000 ohms, C7, 2 mfd., and VD, a 500,000 ohm voltage divider. The output filter of the amplifier should consist of a 100 henry choke Ch and an 8 mfd. condenser C8.

The four ballasts R should be 4 ohm resistances if 201A tubes are used for the first three and a 171A for the last. Grid bias battery E1 should be adjusted for maximum output, E2 should be 40.5 volts, E3, 6 volts, the left part of E4 should be 45 volts, and the total E4 should be 180 volts.

C0 and C9 should not be smaller than 2 mfd. each and should preferably be much larger. C5 and C6 should be 0.001 mfd. each and coil L7 an 85 millihenry radio frequency choke.

Coils for Oscillators

The two coil systems L1L2L3 and L4L5L6 should be the same, at least at the beginning. The most suitable coils are small duolateral wound coils wound on half inch wooden dowels but these may not be available in the right number of turns. Hence we shall give the design of coils wound on 3 inch bakelite tubing, assuming that the capacity in each circuit is 550 mmfd. and that the frequency is to be 200,000 cycles. We will need 1150 microhenries for each of L1 and L4, which will be given by 125 turns of No. 28 enameled wire. This winding will require about 1.7 inch of the form. The tickler windings L2 and L5 should have 2/3 as many turns as the tuned windings, or 83 turns. There need be no separation between these windings. The pick-up winding on each coil should be wound at the grid end of L1 or L4 and there should be a separation of 1/4 inch between them. Fifteen turns will be enough for L3 and L6. Thus the total number of turns will be 223. The wire winds 74 turns to the inch and therefore the windings will take up nearly 3 inches. If the space between the tickler and the tuned windings be added, and 3/8 inch be allowed at each end for mounting, the total length of the form will be four inches. Thus the coils are large and clumsy but they are good coils for the purpose.

(Continued on next page)

500 Cycle Cut-off Filter

How to Compute Values of Capacity and Inductance

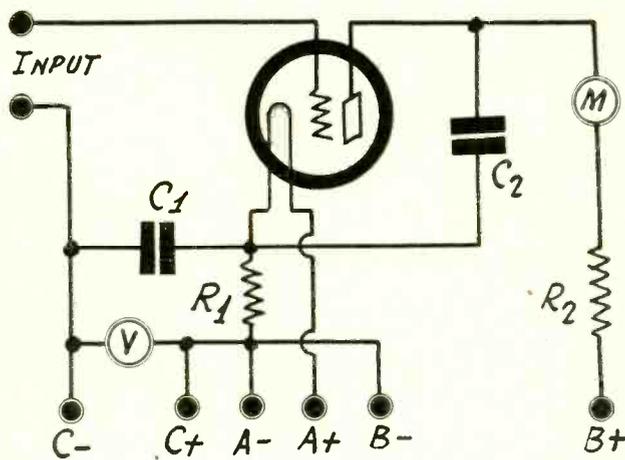


Fig. 10

A peak vacuum tube voltmeter which may be used for measuring either RF or AF voltages as well as for determining the degree of modulation.

(Continued from preceding page)

For measuring harmonic content in the output of a receiver a high pass filter such as that shown in Fig. 9 might be placed between the output tube and the measuring device. This filter should have a high attenuation for the fundamental and practically no attenuation for the harmonic frequencies. If the fundamental is 400 cycles per second, that standard test frequency, the cut-off of the filter should be between 400 and 800 cycles. The impedance of the filter should also be equal to that of the load impedance of the tube used in the last stage, and the resistance R should be equal to the iterative impedance of the network.

The frequency of the cut-off is determined by the equation $W^2 = 1/4LC_2$, in which w is 6.2832 times the cut-off frequency. L_1 is the inductance of either choke L_1 and C_2 the capacity of the series condenser C_2 in Fig. 9. Either of condensers C_1 is twice as great as C_2 .

The iterative impedance spoken of above is determined by the equation $Z^2 = L_1/C_2$ for frequencies high above the cut-off, in which L_1 and C_2 have the same significance as above.

Suppose we wish to construct a filter with a cut-off at 500 cycles, 100 higher than the standard test frequency. To get the cut-off at this frequency we have to make the product of L_1 and C_2 equal to .0253 divided by one million. We have to get the value of each one by choosing the proper iterative impedance. If the load impedance on the tube in question is R ohms this should equal the iterative impedance. Hence $R^2 = L_1/C_2$. Now we can combine the equation for the product of L_1 and C_2 and that for the ratio and determine both in terms of R and the design of the filter. For the inductance of L_1 we get 0.159 R divided by 1,000 and for the capacity of C_2 we get 0.159/1,000 R .

Getting the Values

If the tube in question requires a load impedance of 4,000 ohms, the inductance of L_1 should be 0.637 henry and the capacity of C_2 should be .0398 microfarad. The capacity of each of C_1 should be .0796 microfarad. The value of R should be the same as the value of the iterative impedance, namely, 4,000 ohms in the case worked out. This filter will have a cut-off at 500 cycles per second, below which it will pass extremely little and above which it will pass all frequencies with little attenuation. The impedance far above the cut-off will be 4,000 ohms, and this is the value at the first harmonic, 800 cycles, within about 20 per cent.

The cut-off will be sharper the lower the resistance of the two chokes. For this reason they should be wound with heavy wire on large iron cores of the best core material.

Since it is not practical to have a filter for every tube it is better to use a transformer between the tube and the filter which will match impedances. The secondary of this transformer should always "look like" a resistance of 4,000 ohms to the filter and the primary should always "look like" an impedance equal to the load impedance of the tube. To fit the filter to different tubes it is either necessary to have a transformer for every tube requiring a load impedance different from 4,000 ohms, or else have one the ratio of turns of which may be varied.

If the load impedance is r ohms and R is the iterative impedance of the filter, the turns ratio required may be determined from the relation $A^2 = r/R$, where A is the ratio of turns. As an example, suppose the tube requires a load impedance of 8,000 ohms. Then

the ratio of the resistances is 2, and the ratio of turns should be 1.414. A step-down transformer of this ratio would be required.

Measuring Harmonics

The thermocouple milliammeter G measures the effective value of the total harmonics, assuming that there is no attenuation on the harmonics. A previous measurement without the filter, using the same type of meter, measured the root mean square of the fundamental as well as the harmonics. The distortion is defined as the ratio of the square root of the sum of the squares of the amplitudes of all the harmonics to the amplitude of the fundamental. The distortion may be obtained by using the squares of the effective values. The square of the effective value of the fundamental is obtained by subtracting the square of the effective value of the total harmonics from the square of the effective value of the total current. Suppose the total current measures 120 milliamperes and that the harmonic current measures 20 milliamperes. The fundamental therefore is the square root of the difference between the squares of 120 and 20. This is 118.4 milliamperes. The harmonic current is measured directly and was assumed to be 20 milliamperes. Hence the distortion is 20/118.4, or nearly 0.17. That is, the distortion is 17 per cent. of the fundamental.

Modulation Meter

For the purpose of measuring the percentage modulation a peak vacuum tube voltmeter is used. Such an instrument is shown in Fig. 10. Since this may be used for measuring very low voltages as well as radio frequency voltages, it is recommended that the by-pass condensers C_1 and C_2 be made 4 mfd. or larger. R_1 is just the ballast resistance required for the tube used in the meter. For a 240, which is recommended because of the sharp cut-off of the plate current as the bias is increased, it should be 4 ohms on a 6 volt filament battery. The plate voltage may be any desired value. For example, 90 volts is satisfactory.

V is a voltmeter which measures the grid bias required just to cut off the plate current as indicated by the meter M in the plate circuit. R_2 is any suitable resistance which will limit the plate current to a value required by the meter M .

The operation of the peak voltmeter is as follows: The bias is increased until the plate current is just reduced to zero when the input terminals are short circuited. The voltage to be measured is impressed across these terminals and the bias is increased until the current in M is again reduced to zero. The second bias, as read on V , less the reading obtained with the input terminals shorted gives the peak value of the voltage impressed.

The Peak Increases with Modulation

When a radio frequency current or voltage is modulated the peak of the voltage is greater than when it is unmodulated by an amount depending on the degree of modulation. Hence if we first measure the amplitude of the unmodulated voltage with the peak voltmeter and then measure it again when it is modulated, it is possible to deduce the degree of modulation from the two readings.

If the degree of modulation is k and the peak value of the unmodulated carrier is E , the peak of the modulated voltage is $E(1+k)$. Therefore if we divide the measured peak obtained on the modulated voltage by the peak obtained on the unmodulated, we get a value equal to $(1+k)$ and all we have to do is to subtract unity from the ratio to obtain the degree of modulation. The theory is extremely simple. The greatest source of error comes in determining when the plate current is just reduced to zero. If the reading is not reduced to quite zero, but to a very small value that can be duplicated each time, the error will be smaller than if an attempt is made to reduce the current to zero. For most tubes it is not easy to reduce the current to zero because instead of cutting off sharply, it tails off gradually. The error will be very small if the voltages involved are large.

Hum Measurements

Every receiver should be tested for hum. This could be done by measuring the effective hum voltage across the load impedance when no signal is being received but when the circuit is in operative condition. But the results would not be a measure of the hum heard. The loudspeaker cuts out much of the hum due to the fact that it is not as sensitive on the low frequencies as on the high. In order to get an estimate of the effective hum, a filter having the characteristics of the average speaker should be interposed between the receiver output and the vacuum tube voltmeter used for measuring the hum.

A filter of this type is recommended by the Institute of Radio Engineers and has the following characteristics: A coil of 0.9 henry inductance and a resistance of 180 ohms, including the

(Continued on next page)

Coils for An Oscillator

Winding Data for .0002 mfd. Condenser, 520 to 16,000 kc.

THE modulated oscillator circuit published last week was changed slightly in order to simplify the coils. This change also improved the circuit in that it removed one chance for frequency variation. The change consisted of removing the winding marked L1 on Fig. 1, page 3, and connecting the grid of the first tube to the grid of the oscillator. This alteration changes the frequency of the circuit by 10,000 cycles, approximately, in the upward direction. That is, where the lowest frequency was 510 kc. before it became 520 kc. after the change. Thus the capacity was decreased by nearly 4 per cent of the maximum, or by about 8 mmfd.

Capacity Changes

This change seems very small, but it is too large to permit after the circuit has been calibrated. Suppose, for illustration, that the circuit at first has a frequency range of from 510 to 1,220 kc. This indicates that the capacity ratio between maximum and minimum is 5.71. If the maximum capacity in the circuit was 200 mmfd., the minimum was 35 mmfd. Now let the change in the circuit cause a decrease. In the zero setting capacity of 8 mmfd. The new maximum is 192 mmfd. and the new minimum is 27 mmfd. The ratio is 7.12 and therefore the frequency ratio is 2.67. If the new low frequency is 520 kc, as we found it to be, the new high frequency is 1,388 kc. The old calibration, therefore, is considerably out at the high end of the frequency scale.

Frequency Alteration

There are many changes in the arrangement of the circuit that may produce frequency changes greater than should be permitted. For example, if the oscillator is mounted on a metal plate the distributed capacity will have one value and when the plate is removed it will have another. If the plate or filament voltage is changed, the frequency will change. This is partly due to a change in the capacity and partly to a change in the internal plate resistance of the tube. Leads moved around will alter the capacity, and to some extent the inductance, and therefore the frequency. Since these changes will affect the frequency and the calibration it is important to use the circuit the same way every time, that is, with the same filament voltage, the same plate voltage, the same tubes in the same sockets, the coil plugged in all the way down every time, and leads disposed the same way every time. There are many uses, however, of the scollator where such small frequency changes do not make any difference.

Changing the circuit as was suggested above is a major change. So is using a different type of tube in the oscillator socket. So is a large change in the plate voltage. They should be avoided even when only an approximate value of the frequency is wanted. A change from 1,220 to 1,388 kc. is entirely too much.

Coil Data

A set of coils has been worked out for this oscillator. All are wound on tube base forms. 1.25 inches in diameter, with No. 32 enamel wire. The wire was somewhat oversize so that it would

104 turns to the inch instead of 112, the average. But such variations are of little importance.

Coil	L2 turns	L3 turns	Inductance
1	140	50	418
2	48	32	88
3	16.5	11	16.22
4	6.18	4	3.01

The inductance is given in microhenries and is the approximate value of the L2 winding. The fractional turns should not be taken too seriously. Every winding will have a fractional turn because of the arrangement of the prongs. Since the low potential ends of both L2 and L3 are connected to K and K and P are approximately on opposite sides of the form, L2 on all the coils will have a half turn. L3 will have about a quarter turn or a three-quarter turn depending on whether the winding is right-handed or left-handed. The coils constructed for this oscillator were all wound as a left handed screw. The overlapping of the coils is small but it is sufficient to take care of a fractional turn and ordinary variations in the distributed capacity.

Collodion Applied

A layer of collodion should be applied to the coils after they have been wound and before the calibration has been done. This will help to hold the wires in place and so to keep the inductance as well as the distributed capacity constant.

The tuning range of these four coils is from about 250 kc. to 16,000 kilocycles. If it is desired to extend the range another coil may be constructed. For the purpose of determining the turns of the smaller coil it may be assumed that the frequency is inversely proportional to the number of turns. Thus if 6.19 turn coil tunes to 16,000 kc., it would require a coil of 3.3 turns to tune to 30,000 kilocycles. Or a coil of 3 turns would tune up to 32,960 kilocycles.

Grid Coil Smaller

It will be noted that the coil in the grid circuit is always much smaller than the coil in the plate circuit, or the tuned coil. The reason for this is that the oscillation is less intense that way and the generated wave is more nearly pure. If the secondary or grid coil were tuned, the same effect would be obtained by making the tickler winding smaller, or the coupling between the two coils relatively loose. Harmonics are advantageous in the process of calibration but afterwards a wave as pure as possible is desired in most instances.

All the coils are supposed to be wound with the turns as close together as possible, and the inductances have been determined on that basis. The separation between the primary and secondary windings is of little importance just so they are close enough to produce oscillation at all settings of the tuning condenser. On the largest coil it was necessary to start one winding where the other left off in order to get the turns on. At that it was necessary to cut down on the number of grid winding turns. For all the other coils there is ample space.

A Low Pass Filter for Testing

(Continued from preceding page)

resistance of the coil, connected in series and across the output terminals of the receiver; a condenser and a resistance in series and then in parallel with the 0.9 henry coil and the 180 ohm resistance. The resistance in series with the condenser should be equal to the internal resistance of the tube and the condenser capacity depends on the value of the resistance. For a 5,000 ohm resistance the condenser should have a capacity of 0.045 mfd. and for a resistance of 2,000 ohms the capacity should be 0.065 mfd. The vacuum tube voltmeter is connected across the high output resistance.

If peak values of hum voltage are to be measured the circuit in Fig. 10 may be used, or a more sensitive vacuum tube voltmeter of the same type.

A Low Pass Filter

The fundamental alone could be measured directly in the same manner as the harmonics by interposing a low pass filter with a cut-off at 500 cycles per second and with the same impedance. Only the fundamental would then be transmitted to the meter G. In the low pass filter a coil is used in the place of every condenser and a condenser in place of every coil. The inductance of the coil taking the place of either C1 would be one-half that of the inductance of the coil taking the place of C2. The condensers taking the place

of coils L1 would be equal, just as the coils are equal.

The cut-off frequency is determined by $w^2=4/LC$, in which w is 6.2832 times the frequency, L the inductance of the choke coil in the middle, and C the capacity of either condenser in shunt with the line. The cut-off frequency would be placed below 800 cycles per second, say at 700 cycles. For frequencies much below the cut-off the iterative impedance is the square root of the ratio of the inductance of the middle coil and the capacity of either shunt condenser. That is, it is the same as for the high pass filter, except for the actual values of L and C, which depend on the frequency of the cut-off.

Design Formulas

If the cut-off is to be at w, where w is 6.2832 times the frequency, the inductance of the middle coil should be $2R/w$ and the capacity of either shunt condenser should be $2/Rw$, in which is the iterative impedance as well as the load impedance. Suppose R is 4,000 ohms as before and the cut-off frequency is to be at 700 cycles per second, we obtain 1.82 henries for L and .1134 mfd. for the condenser. The value of either end inductance should be 0.91 henry.

The filters described contain two equal "sections" and are the simplest type of each. The termination is mid-series because the impedance of the two end series impedances is just half the impedance of the middle series element.

Meter Band Selector Switch

B. Herman

in the polarities of connections. If the windings are in the same direction, then adjoining terminals of the coils go to grid for the secondary and to plate for the tickler. Assume theoretically that L2 and L3 consist of a continuous winding, and that this winding is cut to permit of two coils. The cut terminals go to grid and the plate as explained.

There are four binding posts, two for antenna and ground and two for the output (plate and B plus). At the output ear-phones may be connected, or, if you would like to have loud-speaker volume you may connect the plate output post alone to the P prong of the detector socket of a broadcast set. The detector tube of the broadcast set would be removed and would stay removed so long as the output of the little one-tube set is connected to the audio input of the big set. In that case the C battery otherwise used for B voltage in the little set is not effective, but the plate voltage on the tube in the little set is the B voltage supplied from the big set's detector output circuit.

Completion of Tuned Circuit

The grid condenser may be the usual .00025 mfd., as this is a good compromise, particularly because of the wide frequency range of tuning. The grid leak may be any value from 2 to 5 meg. and is not critical.

It will be noticed that the tuning condenser (.00035 mfd.) has rotor grounded, but that the secondary coil is returned to filament plus (same as A plus), so the tuned circuit is returned to ground from the coil through the resistance of the filament, 33.3 ohms, and the resistance of the filament resistor, 15 ohms, a total of 48.3 ohms. This is a relatively large resistance for radio frequencies, so a bypass condenser of .0015 mfd. or larger capacity is used to complete the tuned circuit to ground.

The coil is returned to positive A because positive bias affords much better sensitivity with the 230 tube.

Battery Life

The 230 tube draws about three times as much current as a flashlight bulb, so the A battery is good for about thirty or forty hours use. However, the C battery, used for plate voltage, draws little current, depending somewhat on the DC resistance of the earphones, if any are used, but being in the neighborhood of 1 milliampere. Thus the plate battery should last a long time.

It should be borne in mind that the B battery is automatically out of use when the little set is connected to the detector of a big set, so if the intention is to enjoy that service exclusively, the B battery of 7½ volts isn't necessary at all.

Stops Hum

Legge

unless steps are taken to "kill" such radio impulses at the source.

The large condensers afford an easy path for the radio impulse direct to the "ground" and since they are located right ON the device where they start, they do not travel via the electric wiring far enough to radiate their energy into space—to your receiving aerial and lead-in.

Where the spark is greater and more vigorous—the filter must be more effective, and in that case choke coils are employed in conjunction with the condensers already described. The electric supply current for the electrical device passes through these coils, so that the filter must be carefully designed with a view to carrying the current necessary without heating unduly.

Noise Travels on Wire, Too

In a few instances, the noises follow the electric wiring to your set, and they can be stopped before reaching it by installing a line noise eliminator. As a general rule, however, the interfering waves are radiated from the house wiring and are picked up by the receiving aerial, so that it is usually difficult to stop the trouble except at the source. Of course it is not difficult to locate which device in your home is the trouble-maker—simply by adjusting the set to the point where the sounds are the loudest, and trying one device at a time—such as the refrigerator, oil burner, fan, mixer, vacuum cleaner, electric signs, motors, bells, buzzers, etc.

If you cannot find the cause of the noises, have the service man try his luck—because in most cases, the noises can be done away with or greatly reduced.

Sources of Lists of World Stations

The following data on sources of station lists were compiled with the assistance of the Department of Commerce, Radio Division, and answer questions often asked:

The International Bureau of the Telegraph Union, Radiotelegraph Service, Berne, Switzerland, now has available for distribution to the public a list of stations of the world in order of frequencies, dated January, 1931. This document contains 445 pages and may be brought up to date by recapitulative monthly supplements. The price of the list and supplements which will be issued until November of the current year is 25 Swiss francs (\$4.83), postage included. All remittances are required to be made direct to the Berne Bureau by international money order.

A list of stations of the world operating on short waves may be obtained from the Radio Amateur Call Book, Inc., 506 South Dearborn Street, Chicago, Ill., at \$1.00 a copy.

The International Short Wave Radio News also lists short wave stations. This publication may be obtained from the International Short Wave Radio League, Box 22, Jamaica Plains Station, Boston, Mass., at 10 cents a copy, subscription price \$1.00 a year.

Lists of short wave stations in this country are contained in the June 30, 1930, edition of two government books, "Commercial and Government Radio Stations of the United States" (15c) and "Amateur Radio Stations of the United States" (25c.). The first-named publication may be kept up to date by consulting the monthly Radio Service Bulletin which is supplemental thereto. These publications may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the prices indicated. All remittances should be forwarded direct to the Superintendent of Documents by money order.

A list of the short-wave stations of the world, with hours on the air, in order of frequency, with wave given, was published in the March 28th issue of RADIO WORLD, with addition in the April 4th issue. 15c a copy from the RADIO WORLD, 145 West 45th street, New York, N. Y.

Short-Wave Club

ARE you interested in short waves? Receivers, transmitters, converters, station lists, trouble shooting, logging, circuits, calibration, coil winding—what not? If so become a member of Radio World's Short-Wave Club, which you can do simply by filling in and mailing attached coupon. As many names and addresses as practical will be published in this department, so that short-wave fans can correspond with one another. Also letters of general interest on short-wave work will be published. Besides, manufacturers of short wave apparatus will let you know the latest commercial developments. Included under the scope of this department is television, which is spurting forward nicely. Fill out the coupon and mail at once.

Readers who have favorite short-wave circuits should send them in with a report of the results obtained. Arrangments are being made to answer questions on short waves, also.

Short-Wave Editor, Radio World, 145 West 45th Street, New York, N. Y. Please enroll me as a member of Radio World's Short-Wave Club. This does not commit me to any obligation whatever.

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The Effect of Couplin

By Herma

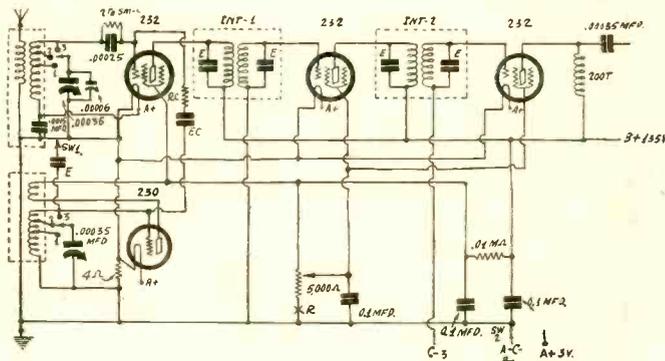


FIG. 1

A series circuit, comprising resistor RC and condenser EC, is used for uniting modulator and oscillator. Strict independence of tuning may be achieved this way. The circuit is for battery operation.

IN short-wave work there are two essential inductive requirements, (1), coupled coils, and (2), isolated coils. The coils may be regarded as coupled in any instance in which the circuits are mutually inductively coupled. The isolated coils are those in circuits wholly independently operated.

Take as an example a short-wave converter or set that uses the superheterodyne method of reception. In every instance there is coupling between modulator and oscillator. Therefore the two coils may be inductively coupled by being wound on the same form, and if shielding is used, one shield serves for both. This method applies even though each circuit is separately tuned. It was the basis of the tuning element described in last week's issue (May 23rd), a single switch being used to change the frequency bands.

A circuit was published in that issue for an AC-operated short-wave converter, or, really, an all-wave converter, since the coverage was from 15 to 600 meters. Coil data were given. Likewise a battery-operated counterpart, using the 2 volt tubes, was diagrammed.

Series Circuit for Coupling

External or other methods of coupling of course would be inductive, capacitative or resistive, or a combination of any or all of these. An example of capacitative-resistive coupling is shown in Fig. 1 herewith, which is otherwise like the battery circuit of last week. A series circuit, comprising the coupling resistor RC and the coupling condenser EC, is used to unite the grid circuits of modulator and oscillator. The degree of coupling depends on the capacity and the resistance values. Usually a high value of resistor, around 1 meg., and a low value of capacity, .00025 mfd. or less, is used. The smaller the capacity of the

condenser and the larger the resistance of the resistor, the looser the coupling. In mixed circuits like these loose coupling always is required to maintain independence of tuning, otherwise the two circuits tend to tune as one.

It is possible to get good results with a single tuned circuit. The reason obviously is that there are multiple tuned circuits, although only one is manually operated in that instance, through the oscillator tuning condenser. The intermediate stages are tuned, of course, although to a fixed frequency, whether the entire intermediate chain is in the receiver with which the converter is worked, or whether there is some intermediate frequency amplification right in the converter, as in the instance set forth last week, and as comprised also in Figs. 1 and 3 this week. There are two intermediate stages built in, and the couplers, Int. 1 and Int. 2, are tuned to some low frequency near the broadcast band, and the set with which the converter is used of course is tuned to the same frequency.

Second Tuned Circuit Helps

When there are two tuned circuits the effect of relatively tight coupling is an improvement nevertheless over the use of only one tuned circuit. The modulator tuning tends to be of the same frequency as that of the oscillator tuning, and the incoming signal frequency is not tuned. The oscillator amplitude is elevated thereby, since the resonance curve is higher when there are two tuned circuits, or at least this applies to the frequency to which the oscillator is tuned. Then, even with a non-oscillating modulator, the frequency of the oscillator is of increased amplitude on the tuning curve, and it makes little difference if this double tuning were applied to the oscillator alone, or were applied separately to the oscillator and the modulator, since in the modulator mixing takes place anyway.

A meter in the output circuit of Fig. 1 would confirm this, as the plate current reading would be higher when there were two tuned circuits, even if more closely coupled in the mixer than ordinarily recommended.

A choice of degree of coupling may be desired, with utter independence of the two tuned circuits, except for such unison, which is slight, required for producing the intermediate frequency from modulator tube. That is, the tuning will be strictly independent. This makes for more selectivity, because then the modulator is truly tuned to the incoming carrier frequency, and the amplitude of that frequency is raised. So you have both increased selectivity and increased amplification, whereas in the closely coupled circuits you have only increased amplification.

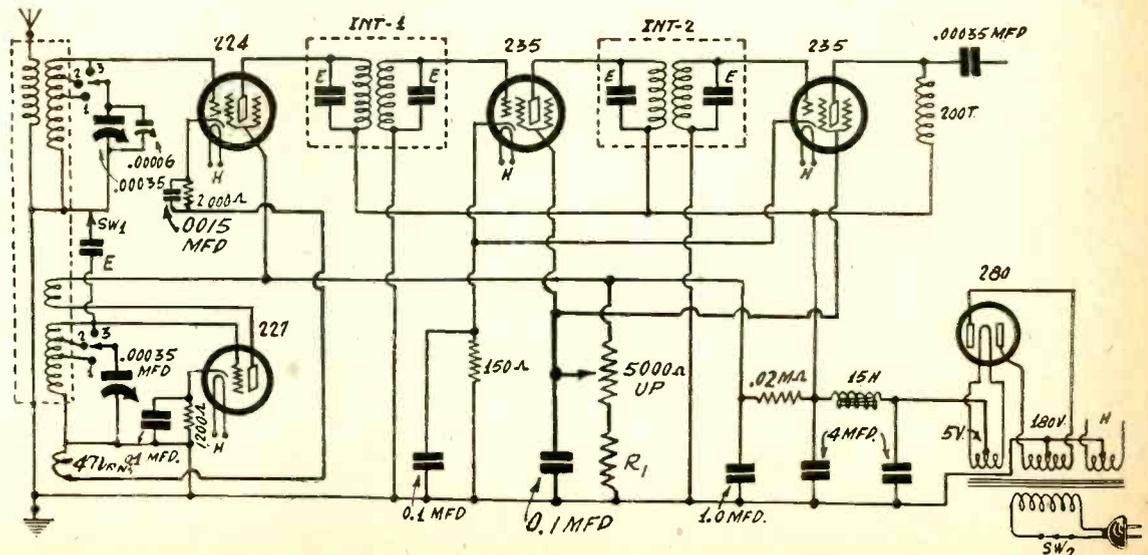
Cathode Coupling

A condenser alone, such as EC, could be used for joining the two circuits, and could be adjusted to the smallest value that gives the mixing result. In that instance a trimmer of 20-100 mmfd. may be used, and once adjusted left thus. A resistor alone could not well be used in this way.

Another method, one that works well, is to put four turns of wire at the end of the oscillator (from grounded side), and

FIG. 2

A 4 turn coupling coil is used to unite the two components in this all-wave converter. The ground connection for this pickup coil may be a tap on the winding otherwise used for secondary. RI may be 800 ohms or so. Complete A, B and C supply is built in.



Losses in Aerials

By Brainard Foote

LOSSES in radio receiving installations are very numerous. The amount of current generated in the receiving aerial by a passing radio wave is so small that even slight losses will make a considerable decrease in the final volume.

The antenna deserves great care from the viewpoint of losses. First, consider leakage. Where the insulators are not good ones, or where they are dirty, some of the electric current may leak off to the earth via trees, ropes, etc. The insulators should not be too small—they must be of good material, preferably with a hard surface that does not catch dust and grime—and they must be clean. Two insulators in series at each insulated point will give better insulation.

High Resistance Losses

Next about resistance. Anything which impedes the passage of the current should be avoided. For example, if we employ iron wire instead of copper wire for the aerial, much less current would flow because of the poorer carrying power of iron. Assuming that the wire is O. K., the same detrimental effect would occur if you had a poor joint somewhere in the aerial system. An unsoldered joint is a usual point of high resistance. Joints ought to be soldered, or if a long enough wire is used, the entire aerial and lead-in will be one and the same piece of metal, requiring no joints at all.

Another form of aerial loss is by capacitive leakage from the aerial wire to other objects near by. The current actually jumps through the air in the same way as it does between the plates of a condenser. Naturally, the nearer the aerial wire is placed to the building wall, roof, trees, gutters, etc., the easier it will be for this loss to take place. The remedy is clear. Use wide spacing—5 or 10 feet from the wall—for the lead-in, with plenty of separation between the wire and all other objects or wires. If other wires cannot be avoided, run your aerial at right angles rather than parallel to them.

The aerial and ground system operates much like a radio coil and condenser circuit. The radio wave causes current to flow up and down in the aerial, and the strength of this current is dependent to no little extent upon the nature of the contact made with the ground.

Multiple Grounds Recommended

Homes with a city water system have little difficulty in effecting a good ground connection, but there are improvements, even for them. Several different ground wires, one to the basement water main, one to a nearby radiator, another to a water pipe in the next room, etc., have the effect of increasing the earth contact. Louder signals usually result. Poor contact often exists in joints in the pipe, especially in gas pipes, and the use of a number of different ground wires gets around such difficulties. Never use a gas pipe as ground.

The farm radio listener has a special problem as to the ground, except where he is on the city water system. There are several methods of effecting the ground connection, one of the worst being the popular one of driving a few feet of iron pipe into the

soil and attaching a wire to it. This pipe has so little surface area that the contact with the soil is small and poor. Because of the great resistance of the soil, it is necessary to provide a path of very large area, so that the flow of current from the aerial will not be interrupted. One of the best, although admittedly not easy to assemble, is known as Round's Round Ground, having been advocated by a Captain Round.

Carefully Constituted

It is a metal cylinder 15 or more feet in diameter and about 2 to 3 feet long, buried in a circular trench in the ground. The cylinder is made up of a series of galvanized iron pieces about 2 by 6 feet, riveted or soldered together at the ends and the entire piece shaped into a circle. A heavy copper wire is soldered to each section of the cylinder, and all these wires are soldered together and to the main ground lead at the center of the circle.

Other good grounds are made of metal pieces or screens buried in trenches. The main idea is to get a large area of soil contact; if possible, where the ground is damp or frequently moistened. Use all the available ground contacts to get the best results.

A common mistake is that of running long and devious wires to the radio set. The best way is to put the set where the lead-in wire will reach it without having to be nailed along the walls or moldings. Shortening the wiring reduces the capacitive loss from the wire to the walls; reduces the resistance of the wires; shortens the natural wavelength, which gives better reception at the higher broadcast frequencies.

In short, get as much energy as you can out of the air and get ALL you can to the radio set. Don't waste any of it!

Use a Loop Antenna

Many radio listeners like to use and experiment with loop antennas. In fact, the loop is a useful Summer time aerial. The ordinary outdoor aerial receives with about the same response in all directions. Hence, although the station you may wish to listen to is in one direction only, you get static from ALL directions, or from whichever direction the static may happen to predominate.

With a loop aerial, its directional effect is pronounced, so that it receives only from stations lying in the plane or on a line with it. Static, too, is only received from such directions, so that the loop results in a better ratio of signal to static.

Single Turn Loop

The best loop aerial consists of but a single turn of wire, used with the ordinary variable condenser for tuning. A loop of this style would be about 35 feet on each side, preferably made of heavy or stranded wire like lamp cord, so as to obtain low resistance. Using a loop with an ordinary set introduces an additional tuning control, but results in added selectivity, besides a gain in the proportion of signals to static.

The pick-up is much feebler than from even a small indoor antenna, and not to be compared to that from an outdoor aerial.

Cuban Broadcasting Stations

All Stations of 50 Watts or More Are Listed, With Frequency in Kilocycles, Equivalent Wavelength in Meters, Call Letters, Location and Owner, With Address

kc.	m.	Power	Call	Location	Owner
1,405	213.4	100	CMBY	Havana	Lino E. Cosculluela, Animas número 134
1,327	226	250	CMKH	Santiago de Cuba	Alberto Ravelo, J. A. Saco s/n
1,249	240	250	CMKE	Santiago de Cuba	Edmundo Recamier, E. Palma, baja 72
1,225	244.7	150	CMCA	Havana	Manuel Cruz, Amistad y San José
...	...	250	CMCN	Marianao	Antonio Ginard, Reina y Av. B. Retiro
1,154	260	200	CMHA	Cienfuegos	Fox Bros Co., Gacell núm. 48, altos
1,150	260.7	250	CMQ	Havana	José Fernández, 25 número 445, Vedado
...	...	600	CMCO	Havana	Andrés Martínez, Vista Alegre 80, Vibora
1,070	280.2	150	CMBT	Havana	Emilio Perera, Finlay número 84
...	...	150	CMBG	Havana	Francisco Garrigó, Dragones número 16
...	...	150	CMBF	Havana	M. D. Aufrán, Neptuno número 141
1,034	290	150	CMKC	Santiago de Cuba	M. P. Martínez, Lacret y San Pedro
1,010	296.8	150	CMBZ	Havana	Manuel y G. Salas, San Rafael número 14
...	...	150	CMBW	Marianao	Modesto Alvarez, A entre 6 y 8, La Sierra
...	...	250	CMCX	Marianao	"El Mundo," Aguila número 60
955	313.8	150	CMBD	Havana	Luis Pérez García, Enmorados y Flores
...	...	150	CMBE	Havana	Domingo Fernández, Máximo Gómez número 139
920	235	250	CMHD	Cañarién	Manuel A. Alvarez, M. Escobar número 17
900	333.1	500	CMX	Havana	Francisco Lavín, San Lázaro número 99
...	...	250	CMCF	Havana	Raoul Karman, Rayo número 67
845	354.8	500	CMC	Havana	Cuban Telephone Co., Aguila número 19
834	360	100	CMGA	Colon	Leopoldo V. Figueroa, Martí número 19
790	379.5	150	CMBS	Havana	Enrique Artalejo, Calzada y H. Vedado
...	...	500	CMHC	Tuinucú	Frank H. Jones, Central Tuinucú
730	410.8	3,000	CMK	Havana	Cia. Cubana de Radiodifusión Hotel Plaza
660	454.3	225	CMCO	Marianao	John L. Stowers, Almendares número 58
588	510.0	700	CMW	Havana	Columbus Com. and Radio Co., Paseo de Martí número 103.
550	545.1	250	CMCJ	Havana	Rafael Rodríguez, Estévez número 4

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. Answers printed herewith have been mailed to University Members.

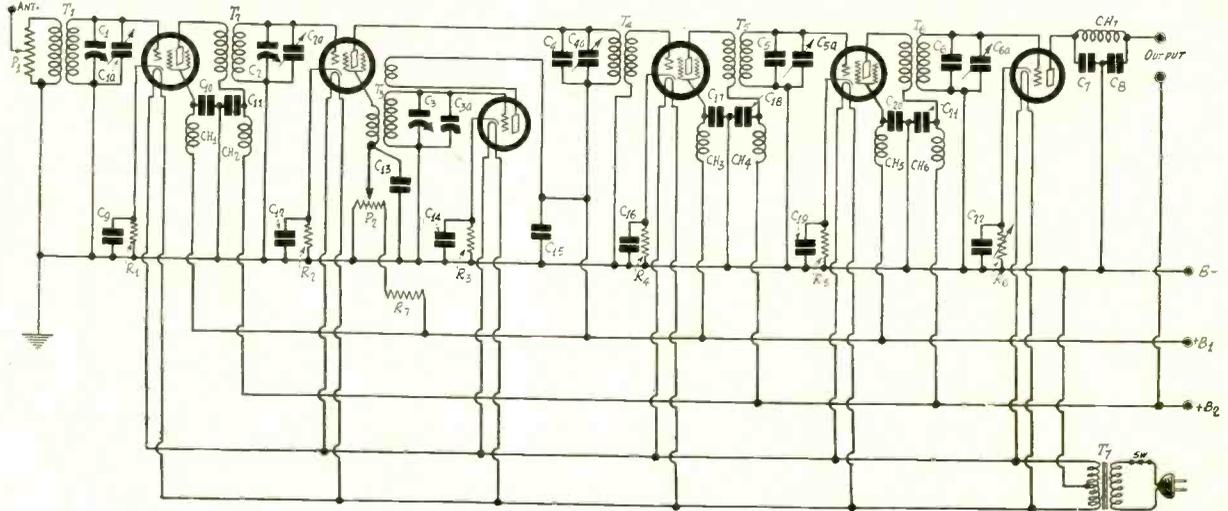
Radio University

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Annual subscriptions are accepted at \$6 for 52 numbers, with the privilege of obtaining answers to radio questions for the period of the subscription, but not if any other premium is obtained with the subscription.

FIG. 922

The circuit of a six-tube superheterodyne tuner that is suitable for use with the 6.3 volt tubes, or the automotive series tubes.



A Six-Tube Superheterodyne Tuner

WILL you kindly publish a circuit diagram of a superheterodyne tuner comprising six of the new automotive series tubes, or a circuit which may be changed over to these tubes without much difficulty? I would prefer a receiver in which there is a stage of tuned radio frequency ahead of the first detector.—T. N. F.

In Fig. 922 is such a circuit. This was designed for 227 and 224 tubes but very few changes in the constants are needed. First, the filament transformer should deliver 6.3 volts instead of 2.5 volts. This is the main change. Next the plate voltages should be adapted to the smaller tubes. B1 might be either 67.5 or 75 volts and B2 should be 135 volts. The bias resistors should also be changed. For every screen grid tube in the circuit there should be a 330 ohm bias resistance. The oscillator bias resistance should be 2,000 ohms, the same as if a 227 tube were used. The nearest commercial values may be used. The variable bias resistance in the detector tube should be about 50,000 ohms. There is no change needed in the tuners, for they are essentially the same for all receivers. The same applies to filters and by-pass condensers.

Transconductance

WHAT is the meaning of the term transconductance as used in connection with vacuum tubes? This term seems to be new.—H. B. M.

The Institute of Radio Engineers defines the term as follows: "Transconductance is the ratio of the change in the current in the circuit of an electrode to the change in the voltage on another electrode, under the condition that all other voltages remain unchanged." The grid-plate transconductance is usually referred to as the mutual conductance. The term transconductance was introduced by Stuart Ballantine and the term mutual conductance by Louis A. Hazeltine.

Input Capacity Measurement

CAN you suggest a method of measuring the input capacity of a vacuum tube and the variation of this capacity with changes in the load on the tube? I am interested in knowing the effect on the amplification of high audio frequencies of the capacity in resistance coupled amplifiers in particular.—W. G. J.

One simple way is by the substitution method. A vacuum tube oscillator may be set with a comparatively large and calibrated condenser. This oscillator may be adjusted to zero beat with a broadcast station or with another oscillator specially set up. The capacity should be noted on the calibrated condenser. Then the grid-filament, or grid-cathode, circuit of the amplifier to be tested should be connected in parallel with the calibrated condenser. This should be done so that there is no change in the grid bias. When this connection is made the zero beat adjustment is changed because of the added capacity. Reset the calibrated condenser until zero beat with the same station is obtained and again note the reading on the calibrated condenser. The difference between the two settings is then the capacity of the grid circuit of the amplifier. This may be repeated for different load conditions in the amplifier to obtain the change in the input

capacity, as well as the absolute magnitude. This method is accurate enough for practical purposes.

Use of Doubly Tuned IF Transformers

IT is now customary to tune both the primary and the secondary of intermediate frequency transformers in superheterodynes. How does this work out when three element tubes are used? Can the circuits be made stable without the use of neutralization?—B. W. R.

If the load on the three element tube is a pure resistance, which it should be if the primary winding is tuned, there will be no feedback through the plate to grid capacity, for regenerative feedback occurs only when load impedance is inductive. Of course, as the tuning is done the load impedance may be either inductive or capacitive and only when the tuning is exact is the load resistive. This is subject to the provision that all the tuned circuits are adjusted exactly to the same frequency. If they are not one tube may have an inductive load when the volume is maximum. When thorough shielding of the tuned circuits and filtering of the supply leads, there should be no trouble. But just the same, it is better to use screen grid tubes when both the primary and the secondary are tuned. In fact, it is better to use them any time.

Adjusting IF Transformers

I HAVE reconstructed 175 kc transformers to have an approximate intermediate frequency of 250 kc, which I did by removing some of the turns. Now I would like to have a method of adjusting them exactly to 250 kc. Will you kindly suggest a method?—C. R. H.

With your receiver tune in a station operating on 1,000 kc. Set up an auxiliary 250 kc oscillator and adjust it until you hear a beat in the receiver output. Adjust it to zero beat. The chances then are that your oscillator is tuned to 250 kc, one-fourth of the signal frequency. As a test, set the receiver on a frequency of 750 kc. There should be another squeal, for this is the third harmonic of the oscillator frequency. Again, tune in a station on 1,250 kc. There should be another squeal. And again, tune in a station on 1,500 kc. There should be still another squeal. If you can get a squeal at 750, 1,000, 1,250, and 1,500 kc, you are certain that the oscillator frequency is 250 kc, because the difference between the squeal points is 250 kc in every case. This may be done on any intermediate frequency.

Comparison of Output Tubes

WHICH is the better tube, the 247 pentode or the 245 three element power tube? What changes are necessary in a circuit now using two 245 tubes in push-pull to adapt it to 247 tubes, if this adaptation is advisable?—E. S.

The 245 has a maximum undistorted power output of 1.6 watts when the plate voltage is 250 and the grid bias is 50 volts, and when the amplitude of the input voltage is equal to the bias. The 247 has a maximum undistorted power output of 2.5 watts when the plate and screen voltages are 250 and the grid bias is 16.5 volts, the signal voltage amplitude being equal to the grid bias. The total plate current for the 245 is 32 milliamperes and the

(Continued on next page)

(Continued from preceding page)

total screen and plate current for the 247 is 39.5 milliamperes. Judge for yourself from these figures. To adapt the circuit to 247 you have to put in UY sockets and connect the K terminals to the plate return of the output transformer, that is, to the center tap of the primary, and also change the bias to 16.5 volts, or a little more. The total voltage in the circuit now is 300 volts, whereas the 247 calls for a total voltage of 266.5 volts. So you might change the bias to about 20 volts. If the bias is obtained from a resistance drop, the resistance should be changed to 210 ohms.

* * *

Effect of Room on Loudspeaker Quality

WHY is it that a loudspeaker connected to a given receiver sounds differently in different rooms or in different positions in the same room? Also, why does the sound change with the position of the listener? I have noticed these effects and I believe they are more than my imagination.—F. G. S.

The reason is very complex, but one effect is that of reverberation and sound reflection. One may just as well ask why a living speaker will sound differently in different positions. A man may speak in a large auditorium without being understood because of echoes. We then say that the acoustics of the auditorium are poor. We never blame the speaker. Out of doors the voice of the speaker is clearly understood, provided it is loud enough. Suppose, then, that we have a perfect loudspeaker to start with. The quality of the sound heard is then due either to the quality of the signal sound the speaker receives from the circuit, or to the acoustics of the room in which the speaker happens to be. We may also assume that the quality of the signal as received by the speaker is constant. Hence we have only the acoustics of the room. Reverberation is the main cause of distortion, and reverberation is different in different rooms, depending on the dimensions, such as height, length, and width. It also depends on the amount of absorbing material in the room, such as carpets, clothing, curtains, upholstery. Again, it depends on the number and size of open windows and doors. Certain dimensions are changed when either the speaker or the listener moves. Standing wave patterns of sound affect the results greatly, and these depend on the frequency of the sound and on dimensions of the room. The ideal place for a loudspeaker is in the open, where there are no walls, trees, or other reflectors.

Curves for 237 Heater Tube

PLEASE publish curves showing the plate current of a 237 heater tube for various grid and plate voltages. How can the current for a given bias and plate voltage be obtained when there is no curve for that plate voltage but when curves for higher and lower voltages are available?—P. J. O.

In Fig. 923 is a family of grid voltage, plate current curves for the 237 tube. To obtain the current for any plate voltage not given on these curves but lying between any two voltages for which curves are given, use direct proportion. Suppose, for example, that the plate current is wanted at 120 volts on the plate and 6 volts on the grid. On the 6 volt ordinate we find that the plate current is 4.2 milliamperes for 112.5 volts and 6.4 milliamperes for 135 volts. Thus 22.5 volts changes the plate current by 2.2 milliamperes. Hence one volt changes it 2.2/22.5 milliamperes. The difference between 112.5 and 120 volts is 7.5 volts. Therefore this voltage change will change the current by $7.5 \times 2.2 / 22.5$ milliamperes. This figures out .733 milliamperes. Hence the current at 120 volts is 4.933 milliamperes.

Duddell Thermo-Galvanometer

WHAT is the principle of the Duddell thermo-galvanometer? Can an ordinary laboratory galvanometer be used in the construction of one of these thermo-galvanometers?—W. L. P.

Everything of the ordinary laboratory galvanometer can be used except the moving coil. In the Duddell thermo-galvanometer the coil consists of a single turn of heavy silver wire in which there is inserted a sensitive thermo-junction. When the junction is heated an emf is generated and this sends a comparatively high current through the low resistance silver loop. The heating element is a platinum strip just below the thermo-junction. The current to be measured is sent through the platinum strip and the heat liberated is communicated by radiation to the thermo-junction. This is the most sensitive AC meter available in simple form.

Power Dissipation in Resistors

HOW can the current-carrying capacity of a resistor be determined when the power rating is given? If the power rating has a certain value is the current-carrying capacity the same in all portions of the resistor? Also, if the power rating has a certain value does this mean that any portion of the resistance will have the same rating in terms of power dissipation?—N. J. L.

The power dissipation W is equal to RI^2 , in which R is the total resistance in ohms and I is the highest allowable current through it. Hence if the power rating and the resistance are known the maximum allowable current can be obtained by dividing the power rating by the resistance (W/R) and taking the square root of this ratio. Suppose, for example, that the power

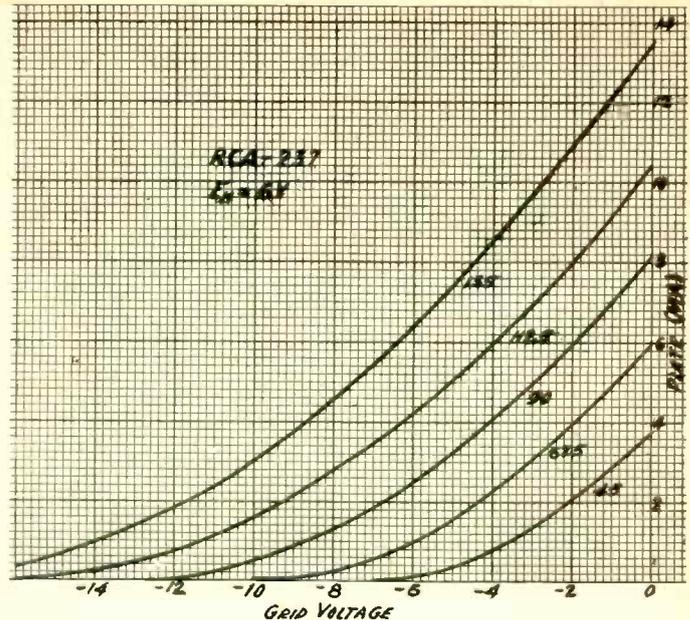


FIG. 923

A family of grid voltage, plate current curves for the 237 heater tube. This tube is supposed to be operated with a plate voltage of 135 volts and a grid bias of 9 volts but the upper curve in the figure indicates that a bias of six volts is preferable for this particular tube.

rating of a 50,000 ohm resistor is 5 watts. Then the maximum allowable current is the square root of $5/50,000$, or 10 milliamperes. Unless the resistance element is specially tapered the current capacity is the same in every portion, but the power rating of a portion of the resistance is not equal to that of the whole.

* * *

Use of Old Transformer

IHAVE an old output transformer which was designed for use with two 210 tubes in push-pull. I wonder if this could be used to good advantage as output transformer with two 247 pentode tubes connected in push-pull.—W. G. H.

The output impedance of a 210 at the maximum plate voltage is 5,000 ohms while the load impedance should be 10,000 ohms for greatest undistorted output. Therefore if the transformer was designed for 210 tubes properly its impedance should be 10,000 ohms on each side. Now the correct load impedance for the 247 pentode should be 7,000 ohms. If it is little higher no harm is done. Hence the match seems to be good. Of course, this is not the only consideration. The match between the secondary of the transformer and the loudspeaker should be right or the load on the tube will not be correct. Properly speaking, the transformer is used to match the impedances of tube and speaker. The impedance of the primary of the transformer depends on what is connected across the secondary and conversely, the impedance of the secondary depends on what is connected across the primary. The transformer should look like 7,000 ohms to each tube in push-pull stage and the secondary should look to the speaker like the impedance of the speaker. To a large extent this is only a matter of turns ratio.

* * *

Use of Variable Mu Tube

WOULD you recommend the 235 variable mu tube for detector in a radio frequency amplifier? May it be substituted for a 224 for use in an amplifier stage without making any other changes?—G.W.T.

The tube has been designed so that it will not detect well. Hence it is not recommended for use in any detector socket. As a radio frequency amplifier it may take the place of any 224 screen grid tube without making any other changes.

* * *

Resistance Coupling Grid Bias Resistor

IWISH to use power detection with a 227 tube in which the plate load resistance is 100,000 ohms, the applied plate voltage 180 volts, and the grid bias is obtained from a resistance in the cathode lead. What should the resistance be to give the right bias? I realize that it must be much larger than if transformer coupling were used but since I don't know the current in the plate circuit I cannot figure out the resistance.—J. W. C.

If the applied voltage is 180 volts this should be divided by the grid bias resistance and the plate resistance in the ratio of 20 to 160 volts. That is the grid bias should be about 20 volts. The best detecting efficiency occurs when the plate current is about 0.5 milliamperes. Hence the grid bias resistance should be 40,000 ohms. It would be all right to use 50,000 ohms.

CASE AWAITED TO DETERMINE LAW VALIDITY

Washington.

The determination of whether there exists a property right to the ether, such as would attach to a license to a station to operate on a particular frequency, is awaited not only by the Federal Radio Commission but also by the broadcasting industry, since the integrity of the licenses already held is at stake.

Incidentally, when the question is finally decided, as it must be, by the United States Supreme Court, the concomitant finding will be reached on the constitutionality of the Radio Law itself.

Organic Law Cited

The principal contention of those who have alleged invasion of property rights by frequency shifts is that the radio law is unconstitutional because in violation of the Fifth Amendment to the Constitution, which prohibits the taking of property without due process of law.

With the constitutionality question settled, and no doubt existing as to property rights one way or the other, the industry as a whole, and the broadcasting structure particularly, would be regarded as on a firmer basis.

Pertinent Case Awaited

As yet no clear-cut case has been presented for the action of the Supreme Court, its decisions on cases involving constitutionality having been on the basis of other contentions in those suits.

Where questions of fact alone arise the legal aspects do not come up, and most of the cases concern facts primarily. However, the cases of WMBB, Chicago, and WCRW, Chicago, raised the legality issue, and as the Supreme Court remanded the WCRW case back to the Circuit Court of Appeals in Illinois, it is expected that the WCRW contention will be before the Supreme Court again soon, and that a final determination will be reached.

Wants It Settled

"The Government is desirous of having a final determination of the issue," it was said at the Federal Radio Commission, "while the interests of the broadcasting industry are such that the license of every broadcasting station may be considered in jeopardy until the matter is finally determined."

It is the opinion of the legal division of the Commission, according to Ben S. Fisher, acting general counsel, that the Radio Law is constitutional, and that the Fifth Amendment does not apply, because radio communication is interstate commerce, on which the Constitution empowers Congress to legislate, and moreover private property rights are subservient to the right to regulate interstate commerce.

Assumed To Be Constitutional

Meanwhile the Commission is administering the Radio Law as if were constitutional, and as if the Fifth Amendment did not apply. It judges the service rendered by stations on the basis of public interest, convenience and necessity.

This follows the general legal doctrine that a law is constitutional until otherwise decided by a court.

Reception Map Recorder Invented

Raleigh, N. C.

A method of analyzing radio reception conditions in different parts of the country, by a vacuum tube recorder that strikes balances to distinguish receptivity conditions, has been devised by Dr. C. M. Heck, head of the department of physics of the North Carolina State College.

He said that he spent three years developing the device, and that now it has reached such a state that it would be possible to send out reception maps just as the Federal Government now sends out weather maps. In fact, he predicted that the Government some day would institute such service.

The device uses chains particularly, and tunes in the key station, say, New York, and notes the difference between reception from this station and any one other station. One other station is taken at a time, and the result is plotted diagrammatically. The prediction is deemed good for one day.

TIGHTER TUBE POLICY GROWS

Tube replacement policy continues to be a concern to tube manufacturers. Some of them have been maintaining an absolute replacement guarantee, but find that after customers have had full use of a tube, sometimes for a year or more, they return it to the retail store or mail order house for free replacement.

In lieu of an absolute guarantee manufacturers are turning to a limited guarantee, the limitation being as to time. Tubes that "do not light" are, in general, not replaced after any use, unless a defect is found due to manufacture, which can be determined by a test of the break in the filament.

The De Forest Radio Company, whose tightened replacement policy is three months old, announced:

"Our existing tube replacement policy simply insists that no replacements will be made on tubes over a year old.

"This policy puts an end to the abuse of insisting on replacement claims for tubes several years old, when the tubes obviously have served their intended purpose.

"We are particularly pleased to note that several other tube manufacturers have followed us with a similar restricted replacement policy and that the radio trade journals have indirectly indorsed the move by advocating tightened tube replacement policies as one means of insuring a fair profit to tube manufacturers, jobbers and dealers. The industry cannot long continue to give tubes away."

Radio World Index Issued by Super Co.

An alphabetical index to RADIO WORLD, from March 21st, 1930, to March 29th, 1931, is published by the Super Company, of 1313 Fortieth Street, Brooklyn, N. Y. The index is printed on heavy paper stock and comprises twelve pages.

The index is complete as to title, author, date of issue and page of issue, and constitutes a valuable possession to the many thousands who retain their copies for reference. Particularly is the index valuable to those who keep the issues in a binder.

Details of the index are obtainable by writing direct to the Super Company.

STATION RATES HETERODYNE AS LAW VIOLATION

Washington.

WROL, Knoxville, Tenn., has brought suit against the Federal Radio Commission in the Court of Appeals of the District of Columbia to cancel and annul approval of the location of WRBI 148 miles away, on the same frequency, 1,310 kc, with 100 watts power, instead of 20 watts formerly used.

The contention is made by WROL that the change was ordered without a hearing, hence WROL had no opportunity to present its factual side of the case, which is that an objectionable heterodyne interference would result when the two stations were operating simultaneously.

Raises Property Right Question

The legal basis of the opposition to the Commission's order is that the change in location and power authorized for WRBI constitutes the taking of property without due process of law, in violation of the Fifth Amendment to the Constitution of the United States.

The same legal argument has been presented in other cases. However, the United States Supreme Court never has passed on the question, nor on the constitutionality of the Radio Law.

WRBI was located at Tifton, Ga., 310 miles from Knoxville, Tenn. The Commission authorized removal to Oglethorpe University, Ga., just outside Atlanta.

Petitioner's Claim

George O. Stutton, counsel to WROL, in his petition stated:

"This action was taken without holding a public hearing and without affording appellant an opportunity to be heard and object to such action, and to present evidence that such a move would result in intolerable heterodyne interference to appellant's station, and cause a reduction to the service area of Station WROL, and cause an unjust and irreparable financial loss to appellant, and that same would not be in public interest, convenience and necessity."

Whistle Called Illegal

The fact of a possible heterodyne is held to constitute a diminution of the station's "property" holding, hence unconstitutional.

Volume Control Card Issued by Electrad

Electrad, Inc., 175 Varick Street, New York, publishes a reference card covering the Electrad line of replacement volume controls and resistors. This card is designed for insertion in a permanent binder or to be placed in a shelf behind the counter for easy reference, or fits conveniently in a sack coat pocket.

A list of 343 receivers which utilize five standardized replacement volume controls is included. This means that by having five different volume controls one is able to service 343 different receivers.

The different types of volume control circuits are illustrated diagrammatically and bear reference numbers applying to the listed receivers. A copy of the volume control reference card is obtainable on application to Electrad.

A THOUGHT FOR THE WEEK

WE wonder what's the matter with RADIO WORLD's subscription orders! They're greater in volume than at the corresponding period of last year. Of course we're not grumbling. What publisher would? When folks ask: "How's business?"—usually the query is made with a whimsical inflection—we reply, "Great!" We mean it, too, when we think of those subscriptions that come rolling in—for, after all, you just can't lick a publication which is so well liked by its readers that they'll send in quite a wad of money for subscription service that runs far into the future.

Depression? What's the meaning of the word? We've deleted the word from our otherwise unabridged office dictionary.

RADIO WORLD

The First and Only National Radio Weekly
Tenth Year

Owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.
Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager; J. E. Anderson, technical editor; L. C. Tobin, advertising manager.

A Stimulating Census

FROM week to week the Director of the Census, from his office in Washington, announces the result of the number of families reporting the possession of radio sets. While the total count has not been completed, as to this aspect of the census, it is quite evident that the average will be encouragingly under fifty per cent. for the entire nation. Current examples of the percentage of families owning sets are: Maine, 39.2, Wisconsin, 51.1, West Virginia, 23.4, Idaho, 30.3, an average for these four of 36 per cent.

The encouragement to be drawn from the figures is that there is an abundant market left, no saturation in sight, and the radio business should be good not only for those who are in the radio business, but for many who are in no business now, and would like to get located.

If the radio is the great entertaining, informational and educational factor that we all assume or know it to be, why is it that so many of us do not act upon the fact? Are those who have no sets convinced that radio is something that offers so much for so little that no one can afford to be without a set? Somewhere the importance of radio has not been driven home. A vast army awaits friendly conquest.

The statistics, even so far as already revealed, are a challenge to those who make radio sets, tubes, accessories. The market may not be affluent just now, but it should be obvious enough that the ones to be convinced that there should be a radio in the home are those who have no radio in the home. Greater effort is now directed to selling a second set to the family that has one set.

The industry should do what it can to locate and identify these non-conformists. It is to be to the benefit of the non-users as well as to the radio trade. The Radio Manufacturers Association should form a special committee to investigate this subject, and a report should be requested containing recommendations for capitalizing on this vast awaiting market. It should be realized that the radio set and accessory manufacturers have been waiting for this market while the market was waiting for the manufacturers, so some unhurried

activity at this time should bring together the two high non-contracting parties.

The first fact to determine is the total number of families and the percentage reporting radio sets. This total is not finally available yet, but soon will be. Then a study should be made of the geographical, ethnic and economic conditions of the localities, in respect to the percentages. Then advertising, sales and distribution facilities should be investigated, in regard to the unsold population.

Radio sets in the homes of those who now have no sets mean the greater importance of radio, better circulation for stations, larger revenue for stations, bigger pay to artists, more business for tube, set and accessory manufacturers, more jobs in radio factories and stations, and a more contented and more enlightened nation.

Will the executives of the radio manufacturers really do something about this, or do they prefer the organized larks that pass for business stimulants? If they prefer the opening of new and real sales outlets, here is a tip:

Cherchez la femme!

Ether Property Right

THE question of property right attaching to a license to broadcast, and the investment made pursuant to the license, has been raised again, this time by WROL, Knoxville, Tenn. The Federal Radio Commission didn't change the frequency of WROL, but did authorize WRBI to move from Tifton, Ga., to Oglethorpe University, Ga., near Atlanta, and increase power from 20 to 100 watts. That would put the stations 148 miles apart, instead of 310 miles. Both stations are on 1,310 kc. The change was ordered without a hearing.

WROL contends that the provision of the Federal Constitution against the taking of private property without due process of law applies, and therefore seeks a court order to annul the change.

The plea of invasion of property right was first made on a grand scale by Charles Evans Hughes, then counsel to WGY, Schenectady, N. Y., which was seeking to retain its frequency of 790 kc, which the reallocation would have changed. WGY retained its desired frequency, but the Supreme Court of the United States affirmed that decision on other grounds, and did not pass on the plea of invasion of property right. In subsequent instances it also refrained from passing on the question, so it is still a moot problem whether such a thing as property right attaches to the ether, hence whether the Radio Law is constitutional. Mr. Hughes, as counsel, likened the case to that of a trademark. Since then he has become Chief Justice of the Court before which he made his argument, and of course will not participate in any of the property right cases involving radio licenses.

The stations' contention in the property right cases arises from the large capital investment and from the goodwill built up, both of these being classified legally as "property." Changing the frequency is deemed to be the taking away of some goodwill, since listeners are accustomed to finding the station of the same old frequency. WROL cites the operation of WRBI so close by as endangering heterodyne interference that constitutes property invasion.

Article V of the Amendments to the Constitution of the United States is relied on in every instance as the foundation stone of the assertion of property right alleged to be invaded. This article provides:

"No person shall be . . . deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use without just compensation."

The Radio Law empowers the Federal Radio Commission to make such changes, deletions and shifts in the broadcasting structure as best will serve the public interest. There is thus a specific grant of

power to change the frequencies of stations, but if Article V of the Amendments is applicable, then the attempt to grant the commission authority to change frequencies is null and void.

The contention that the Commission's authority is real and legal arises from the fact and law that radio communication is interstate commerce. It has been held so in decisions. The power of Congress to regulate interstate commerce is held superior to the claim of a property owner.

Lotteries Dangerous

EVERY time any request is made of the Federal Radio Commission to take action which might be deemed to constitute censorship, the Commission forthwith refuses to act as censor, and states that the Radio Law specifically prohibits that it even attempt to institute censorship. This the law does in plain language.

However, there is no wrong without a remedy, in the theory of our law, and in practice the courts and the administrative agencies seem well able to find a way to remedy a just grievance.

The Commission, for instance, asked by the American Newspaper Publishers Association to ban lotteries and other schemes of chance from the air, refuses on legal grounds but quickly announces that if sufficient complaints are received from listeners the stations complained of will find these charges taken into consideration when applications are made for license renewals.

Lotteries are plentiful on the air, also other schemes of chance, and the fact they are not illegal is simply due to the accident of omission of a prohibitive clause from the Radio Law. The provision is in the Postal Laws, so the publishers are enjoined from printing lottery announcements, while the competitive advertising field is freely open.

It is the sense of the American people, of course, that what applies to one should apply to all, so that the technical omission of a restraining provision from the Radio Law should not be seized upon by any station nor by any advertiser. The only trouble seems to be that the people like their lotteries, as individual possibilities of gaining some economic advantage at no cost, but are opposed to them for the ruin of folk.

The stations should act more seriously about these schemes of chance and take precious good care to prevent their broadcasts entirely, for this is not only the fairer course, but the only safe one. It would be particularly tough on some big station, perhaps the key of a chain, to have its license renewal refused, and to boot to cause the licenses of member stations (that take what programs they can get) to be forfeited also.

Use of Shielding Extended

WHILE horse drawn vehicles are generally considered a relic of a less scientific era, they have not merely survived the obliterating movement of a machine civilization, but are necessary to its efficient functioning, as a means of transportation in the vicinity of the commercial receiving stations, where telephone calls from Europe and South America are routed over the telephone lines to subscribers in the United States.

Interference caused by automobile ignition, which contributes no small portion of the annoying background noise of broadcast program reception, cannot be tolerated in a commercial telephone circuit, and there is a zone, surrounding the Bell Telephone receiving stations at Netcong, New Jersey, inside of which no automobiles are permitted, other than official cars with shielded ignition systems.

These receiving points have even been located away from airplane routes in an effort to avoid background noise, and much of the transportation essential to the maintenance of the station depends upon the horse and wagon.

PLEA TO LEVY TOLL DENIED TO SHORT WAVES

Washington.

The first decision by the Federal Radio Commission on an application for permission to commercialize short-wave transmission—this one in the case of Westinghouse station W8XK, of East Pittsburgh—denies the permission sought, on the ground that short-wave transmission and reception still are in the experimental stage.

All Experimental Now

At present all licenses for short-wave relay work are experimental, but several licensees are trying to obtain commercial ratings, so that charges may be made to advertisers for the transmission of programs on the short waves, just as they are made for broadcasting on the regular receiver frequencies.

W8XK sends out programs of KDKA, and also once in a while special programs. The power is 40,000 watts and the station has been heard in 59 countries. Five different frequencies are used, one at a time.

Westinghouse believed that the sizable audience, nation-wide in scope, which had been established for its relay broadcasting station justified the lifting of the experimental restriction.

Examiner Sustained

The Commission sustained the recommendation of its Chief Examiner, Ellis A. Yost. He held that while the experiments in short wave broadcasting showed interest on the part of numbers of listeners, they did not show development in the art beyond the experimental stage. He said the number of frequencies that may be assigned for relaying broadcasting is limited, and that their use for broadcasting programs direct to listeners would not be an economical one.

Many Educational Stations Pass Out

Washington.

A clash has developed between an educational representative and counsel to the Federal Radio Commission as to whether educational broadcasting stations are getting their fair share of the ether assignments.

Hardships imposed on educational stations have resulted in a large number of such stations being driven off the air, said Armstrong Perry, director of the National Committee on Education by Radio. Ben S. Fisher, assistant general counsel to the Corporation, denied this.

There has been no deletion of educational stations in the past two years as a purposeful act of the Commission, said Mr. Fisher, but such changes of ownership from educational to commercial institutions have been due to voluntary assignments, at the request of the educational stations themselves.

Mr. Perry stated that four years ago there were nearly 100 educational broadcasting stations, while to-day there are only 58, and that not only is commercialism making it difficult for the educational stations to endure, but that the present commercial trend indicates that the Radio Corporation of America and its subsidiaries "will be in control of radio broadcasting in a few years."

The Radio Census

Washington.

Following are recent reports from the Director of Census on the 1930 count, particularly relating to the number of families reporting radio sets:

Maine

The whole number of families in the State on April 1, 1930, was 198,372, as compared with 186,106 in 1920. The number of persons per family in 1930 was 4, as compared with 4.1 in 1920. The number of families reporting radio sets in 1930 was 77,803, or 39.2 per cent. of the total.

Wisconsin

The whole number of families in the State on April 1, 1930, was 713,576, as compared with 595,316 in 1920. The number of persons per family in 1930 was 4.1, as compared with 4.4 in 1920. The number of families reporting radio sets in 1930 was 364,425, or 51.1 per cent. of the total.

West Virginia

The whole number of families in the State on April 1, 1930, was 374,646, as compared with 310,098 in 1920. The number of persons per family in 1930 was 4.6, as compared with 4.7 in 1920. The number of families reporting radio sets in 1930 was 87,469, or 23.4 per cent. of the total.

Idaho

The whole number of families in the State on April 1, 1930, was 108,515, as compared with 100,500 in 1920. The number of persons per family in 1930 was 4.1, as compared with 4.3 in 1920. The number of families reporting radio sets in 1930 was 32,869, or 30.3 per cent. of the total.

* * *

The term "family" as used in making the counts referred to above, signifies a group of persons, whether related by blood or not, who live together as one household, usually sharing the same table. One person living alone is counted as a family, and, at the other extreme, all the inmates of an institution, or all the persons living in a boarding house, are ordinarily counted as one family. The detailed tabulation of the 1930 family statistics will show separately several different types of families, and will give much information as to the number of families of various sizes, the number of families having children, etc., which has not been tabulated in connection with previous censuses.

The Pool of Compulsion

SENATOR DILL'S proposal for solving the dilemma arising from the clause 9 decision sounds very much like an effort to squeeze through one's personal plan for the other fellow's business while the other fellow is attending a funeral.

The Radio Corporation of America didn't do the right thing in trying to compel set-manufacturing licensees to use only RCA tubes as initial equipment. The independent tube manufacturers did not think it was right (and therefore sued), the public must have felt it resembled the use of a club, and even the courts, up to and including the highest one, didn't feel it was right. Now Senator Dill proposes a compulsory patent pool, into which RCA and its subsidiaries and affiliates and associated companies would be forced to cast their patents, to join whatever other radio patents are owned by outsiders. Then anybody who could pay the small fee involved could make sets, construct stations, and be a radio swaggerer generally.

A patent pool might be good for radio, just as one was good in the automobile business, but a pool could succeed only by agreement. In fact, such a pool can't be effected at all, practically or legally, by compulsion. So why ask?

NEW SHIP AID FOR THE PACIFIC BY RF-SOUND

Washington.

Combined radio and sound methods for distance-determination by ships, now in use on the Atlantic Coast and on the Great Lakes, soon will be introduced on the Pacific Coast. The Lighthouse Service of the Department of Commerce so announced. A test is to be made at Blunts Reef Lightship, near Cape Mendocino, Calif.

Compass Necessary

While the system of radio beacons operated by the Lighthouse Service makes it possible to fix the exact position of a ship even in time of fog, a radio-compass is necessary for the reception of these signals. With the new signals, observations may be made with the conventional type of wireless receiving set, which is usually available aboard ship.

A vessel approaching Blunts Reef in fog is able to pick up a radio beacon signal on the radio set or on the radio compass. Listening to the series of dots and dashes he will distinguish, at definite intervals, a long dash. Noting the time that this dash terminates, he will listen for the blowing of the fog signal. This, too, will have special blasts sounding at intervals. The time elapsing between the ending of the radio beacon signal and the ending of the special double blast of the fog signal, is divided by five and the result is the ship's approximate distance in miles from the sending station.

Otherwise Useful

The new signals will be useful in another way also, informing mariners if fog prevails near the lightship when they are still many miles away. If the radio beacon signal is broadcast without the periodical sending of a long dash, it is an indication that the visibility is good at the lightship. If the special long dash characteristic is present, the visibility is low.

Lynch Brings Out Two New Resistors

The Lynch Manufacturing Company, with a new factory in larger quarters in Cranford, N. J., and a larger office than formerly, at 1775 Broadway, New York City (General Motors Building), announces two new units, the 3-watt resistor and the automotive suppressor. The higher wattage resistor is for general use in radio, the suppressor for stopping sparking interference in automobile sets.

The company now makes precision wire-wound resistors for voltmeter multipliers (series) and current meter multipliers (shunt). The accuracy is 1 per cent. or better. The LW-1 type is available from 1 to 500,000 ohms and the LW-2 type from 500,000 ohms to 2,500,000 ohms.

The Lynch metallized resistors for grid leaks and plate circuit loads are increasing in popularity. A. E. Stevens, sales chief, recently returned from a trip that resulted in establishing sales representatives throughout the West, mid-West and South, as well as in New England, so that coverage of the United States is now complete.

The company has the distinction of not only increasing its business, as compared to last year, but its factory and sales facilities as well. All leaks have the new type K filament.

A resistor catalogue is obtainable free. Address the New York office.

DILL ASKS RCA BE FORCED INTO A PATENT POOL

The United States Supreme Court having taken no action to disturb the finding of a lower court that the Radio Corporation of America violated Section 3 of the Clayton anti-monopoly law, by requiring set-manufacturing licensees to equip sets initially with only RCA tubes, Senator Dill claims the Radio Law directs the Federal Radio Commission to refuse license renewals to stations owned by RCA and subsidiaries. In connection with the case he wrote the following article:

By C. C. DILL
United States Senator from the
State of Washington

Now that the United States Supreme Court has decided that the Radio Corporation has violated the anti-monopoly law by its tube clause contract, it is to be hoped that the Radio Commission will not violate the radio law by failure to carry out both the letter and spirit of that statute. That law "directs" the Commission to refuse to grant a license to an applicant who is guilty of establishing a monopoly or attempting a monopoly.

If there be doubt as to the power of Congress to make such a law, let the Commission refuse to grant one license for the purpose of making it a test case in the courts. The Commission can extend other existing licenses while that case is being waged, and meanwhile the Commission will be obeying the law, and the communications service established by the Radio Corporation will not be disturbed.

Wants Patent Pool Broken

But equally as important as carrying out the law in cases of this kind, is the breaking down of the patent monopoly which the Radio Corporation has established. The greatest need in the radio manufacturing industry today is a radio patent pool, similar to the automobile patent pool.

If the Radio Corporation acts wisely, it will cancel the joint patent agreements by which it extorts unconscionable sums of money from other radio manufacturers, and thereby profiteers upon the purchasers of radio sets. By such action it should be able to free itself from further prosecution by the Department of Justice.

Under such an arrangement all radio patents in the patent pool could be used by any responsible manufacturer on payment of a reasonable royalty to the owner of the patent. This would not only free those engaged in the radio industry from threats of suits, but would result in lower prices for radio sets to the public.

Wants Royalties Enjoined

Unless the Radio Corporation makes some such arrangement, it would seem the Department of Justice should not only press the Government's suit to a decision at the earliest possible date, but should ask the court for an injunction prohibiting the enforcement of the indefensible royalty contracts during the period of the suit. The anti-trust law provides for such proceedings and it is highly important that such an injunction be issued to prevent the destruction of independent manufacturers while the case is being carried through the courts.

BREWSTER CHIEF ENGINEER

Oliver H. Brewster, for many years on the engineering staff of the CeCo Manufacturing Company, of Providence, R. I., has been promoted to chief engineer.

Sun Spots Hurt Synchronization

Meteorological conditions are not just right for synchronization experiments, said Harold A. Lafount, Federal Radio Commissioner, after listening in New York City to the synchronization results on WTIC, Hartford, operating on the wave of WEAJ, 660 kc. and of WBAL, Baltimore, operating on the wave of WJZ, 760 kc. He believed the synchronizations were about 85 per cent. effective. He added:

"This is a notoriously poor year for such tests, because of sun-spot conditions, which cause excessive fading and distortion of the sky waves. Engineers informed me that if the synchronization experiments had been attempted last year, when meteorological conditions more nearly approached normal, they would have been 100 per cent. successful."

BOARD HAS EYE ON TELEVISION

Washington.

Engineers of the Federal Radio Commission have just returned from an inspection trip in the New York area, with a report on television transmission and reception conditions. The Commission has found a great increase in television development in the last few months, with a considerable number of reductions to actual practice, so the trip was authorized.

"The television industry has made rapid strides in recent months," it was said, "and two engineers were sent to New York in line with our new policy of sending men out in the field to keep abreast of latest developments."

Lieut. E. K. Jett, U. S. N., retired, and Gerald C. Gross were the two engineers. They inspected the various systems of television employed in the New York area, and obtained comparative data on scanning discs, synchronization, image distortion and programs, including sound-and-sight transmission and reception.

"Our plan is to have our engineers keep abreast of developments in the commercial and experimental applications of radio, so they may have first-hand knowledge of such events," Commissioner William L. Starbuck said. "Whenever the occasion warrants the engineers detailed to particular specialized lines will be dispatched to make field inspections."

Television's new impetus was gained following the opening of new transmitters and the enlarged scope of operation of some existing transmitters.

WISJ on 780 kc Found to Mar WBBM, WMC

Washington.

Denial of the application of WISJ, Madison, Wis., for regular assignment to the 780-kilocycle channel with 250 watts power at night and 500 watts day, has been recommended to the Federal Radio Commission by Examiner Elmer W. Pratt, on the ground of objectionable interference.

Mr. Pratt held that the station, now operating experimentally on this frequency, is interfering with WBBM, Chicago, 770 kilocycles, and with WMC, Memphis, on the 780-kilocycle channel. The Commission, he said, is granting the experimental authorization, specifically reserved the right to change such operating assignment in the case of interference.

ARGUMENTS IN LANGMUIR TUBE CASE FINISHED

Washington.

The Supreme Court of the United States was treated to a lively argument on the suit of the General Electric Company against the DeForest Radio Company, involving alleged infringement of a tube patent by the DeForest Company in the manufacture of tubes for radio receivers and transmitters.

The patent at stake is that of Irving Langmuir, and the court of first instance held the patent invalid, while an appellate court first held it invalid and then, reversing itself, held the patent valid. So now the Supreme Court will speak the final word.

Arguments were closed and the Supreme Court took the case under advisement, after hearing counsel on both sides, one view ridiculing the Langmuir patent as attempting to cover pumping a little more air out of a tube than had been previously exhausted, and the other stating the Langmuir high vacuum patent was "perhaps the greatest of the many great inventions which have emanated from the General Electric Laboratory."

The Prior Art

Ralph B. Evans, counsel for General Electric, paid the tribute to the Langmuir patent, which covers tubes using either two or three metallic electrodes. Sir Ambrose Fleming invented the original two-element tube, the patent expiring on November 7th, 1922, while Dr. Lee De Forest added the grid to constitute the three-element tube, the patent on which expired February 18th, 1925.

These tubes of the prior art were resurrected by the defendants, said the General Electric lawyer, in an attempt to make the court believe that there was no invention in the Langmuir patent, since the others are said to be identical to the present one, but he pointed out that DeForest long ago discarded these early tubes.

The original audion of DeForest was almost laughed at by the General Electric lawyer, who pointed out to the court that the soft or gas-filled tubes were not reliable or very useful as amplifiers.

"They added very little if any impetus to the art," he said. "One great trouble with the DeForest audion was that it was erratic and tricky."

Defendant's Contention

All tubes, except detectors, are infringements of the Langmuir patent unless licensed thereunder, it was contended.

He quoted Judge Morris of the lower court as saying that the Langmuir tube, "because of its stability, reproductibility and power has made possible radio broadcasting, modern radio reception and long distance telephony."

Samuel E. Darby, Jr., and Thomas G. Haight, for the DeForest Company, contended that the Langmuir patent is invalid because it was anticipated by the DeForest audion, there was want of invention and a palpable attempt at "double patenting."

**NEXT WEEK, ISSUE OF
JUNE 6TH, RADIO TRADE
SHOW NUMBER; EXTRA
PAGES; EXTRA FEATURES
BE SURE TO GET IT!**

PLAN IS AFOOT TO WIDEN BAND IN HIGH WAVES

Copenhagen, Denmark.

Extension of the broadcast band to include lower frequencies is expected to come up for discussion at the meeting of the International Technical Consulting Committee on Radio Communications, for which the delegates from all over the world are now gathering here.

Proposals must await the session of the International Radiotelegraph Conference at Madrid, next year, for final action.

The growth of broadcasting, and the necessity for reduction of interference so as to make programs more enjoyable, besides the fundamental problem of accommodating those stations that desire to go on the air, impelled Canada to select 520, 530 and 540 kc, which frequencies it can use without contravening the international convention adopted at the Washington conference in 1927.

Europe Feels Great Need

The subject of increasing the broadcasting spectrum was most strongly agitated in Europe. The International Radiophone Union of Europe at its recent session in Semmering, Austria, recommended that the Copenhagen conference take up the subject, although it is not on the agenda.

The prime purpose of the Copenhagen meeting is to review the technical accomplishments of the past two years and suggest means of applying them to all nations.

Europe's problem is a keener one than that of North America, because of the number of countries involved. The Semmering plan calls for drastic changes. Inter-nation interference is so intense, with all countries compelled to divide wavelengths, that the Semmering conference decided something had to be done for the benefit of listeners.

Europe's Band Wider

In North America a steady campaign has been waged by Canada for more wavelengths, both a larger share of the 96 channels already in use, and also an extension of the number of channels by lowering the frequencies. At present 550 kc is the lowest frequency.

Europe's broadcasting band includes 1,500 to 550 kc, the same as that of the Western Hemisphere, and besides 164 to 190 kc. The Semmering proposal is that the band from 470 to 460 kc be added.

Set Works in Cave, In Air and Under Sea

A radio set brought in programs while located in the Mammoth Cave, Ky., 300 feet underground. Simultaneously a set in a United States submarine, the V-154, and in a dirigible brought programs, as part of a test.

SYLVANIA-NILCO-HYGRADE MERGER

Plans for a consolidation have been approved by the Boards of Directors of the Sylvania Products Company, and the Nilco Lamp Works, Inc., both of Emporium, Pennsylvania, and the Hygrade Lamp Company of Salem, Massachusetts, and recommendations of these Boards will be put before the stockholders for official ratification. Combined sales of these companies amounted to approximately \$9,000,000 for 1930.

Permit Forfeited for 50,000 Watts

Washington.

Refusing to grant any further time extension on the construction permit to use 50,000 watts held by KNX, Los Angeles, for two years, the Federal Radio Commission canceled the permit. It had been extended for three-month periods until now.

Meanwhile twenty other stations are waging strong efforts to get a coveted 50,000-watt permit. Action has been held up following a demand that stations of the Radio Corporation of America and affiliates be denied license renewals on account of anti-trust violation in the clause 9 tube case. Some National Broadcasting Company stations sought 50,000 watts. NBC is a subsidiary of RCA.

IGNORING QUOTA IS VOTED DOWN

Washington.

Voting three to two, the Federal Radio Commission rejected a proposal of Vice Chairman Sykes for licensing new radio stations and increasing facilities for existing stations, regardless of the broadcasting quotas of the various States.

The proposal was a suggested amendment to the regulation prescribing ways for acquiring new broadcasting facilities by the States. This order specifies that no additional facilities shall be granted States which now have more than their authorized quotas, and prescribes the procedure to be followed by underquota areas in obtaining facilities.

The Commission deferred action on a resolution offered by Commissioner Lafount, proposing that all of the five radio zones be treated equally in the matter of simultaneous operation on cleared channels. He brought out that WGY, Schenectady, N. Y., in the First Zone, is operating on one of the eight cleared channels assigned to the Fifth Zone, with KGO, at Oakland. The resolution would provide that Zones Two, Three, Four and Five be allowed the same privilege enjoyed by the First Zone.

They Say

WILLIAM D. TERRELL, director of radio, Department of Commerce.—"It no longer can be said that radio broadcasting is a novelty that soon will wear off, or that it is a luxury to be afforded only by the wealthy. Broadcasting stations are constantly improving the caliber of programs offered to the public, and daily win over greater audiences. While radio receiving set sales have fallen off, radio manufacturers, I am informed, have not suffered as greatly as those in other lines of endeavor. To my mind, this shows clearly that radio is accepted as an integral part of the present-day living standard in this country, for if radio were a luxury or a novelty, people would not invest in receiving apparatus to the extent that they do. The radio set, like the automobile, now is looked upon as indispensable in the average American family. Both are used for pleasure, but both likewise have become necessary from the practical standpoint."

PRESS GATHERS DATA TO DRIVE OUT LOTTERIES

Washington.

The American Newspaper Publishers Association has taken up the Federal Radio Commission on its declaration to set down for a hearing the application for license renewal made by any station about which lottery complaints have been made in considerable number.

Through Elisia Hanson, its counsel, the association has asked members to gather the local information concerning offending stations, and it is to be submitted to the Commission. In this way complaints from "a substantial number of listeners" are expected to be lodged with the Commission.

When the stations apply for license renewal, instead of the formal granting of the application, a hearing will be held at which the lottery complaints will be considered, and the stations' license will be in danger. Without a license the station dare not broadcast, as it is a criminal offense.

Says More Than 50 Offend

According to Mr. Hanson more than 50 stations are broadcasting such objectional programs, including lotteries, lucky number prize awards, jack pot drawings and other schemes of chance. All these come under the Commission's warning. They are prohibited from the press by the Postal Law, rendering any publication containing them unmailable, and the offender liable, but no similar provision was put into the Radio law, through oversight. The Commission has framed a comprehensive bill to be introduced at the next session of Congress to include a restriction in the Radio Law as well.

While the Commission under the Radio Law is specifically denied any censorship authority, this is legally construed as a restriction against editing a program before it is broadcast, but not as preventing the Commission from punishing a station for issuing an objectionable broadcast.

Public Service Is Criterion

In fact, a few stations have been denied license renewals because they broadcast programs including profanity or advertisements of quack doctors.

The Commission's authority to act in respect to the type of broadcasts already radiated arises under the provision of the law requiring that the station's service be in the "public interest, convenience and necessity." That lotteries and other schemes of chance are inimical to this requirement is expected to be the Commission's contention if and when any stations are cited for defense of their license application renewal.

Literature Wanted

- Reuben Balfour, 4216 N. Francisco Ave., Chicago, Ill.
- Simon Spielman, 2063 Mapes Ave., New York, N.Y.
- F. Walter Luley, 1602 E. 84th St., Cleveland, Ohio.
- J. A. Kallus, Box 521, LaGrange, Tex.
- J. H. Dryder, Radio Sales & Service, Richfield, Penna.
- Myer Glick, 242A S. 10th St., Philadelphia, Pa.
- H. A. Simpkins, Jr., 1638 Cone St., Toledo, Ohio.
- Paul Miglin, 1532 E. Miller St., Springfield, Ill.
- Alexander Petrunkevitch, 165 Prospect St., New Haven, Conn.
- Albert Steffens, 1435 Second St., Santa Monica, Calif.
- Chalmer C. Zande, 6208 - 35th Ave., Kenosha, Wis.
- M. J. Stall, Deep River, Conn.
- Robert Cotton, 901 Guardian Bldg., Cleveland, Ohio.
- G. F. Logan, 3133 N. Broad, Philadelphia, Pa.
- H. Leonard Wilson, 831 Lincoln Ave., Cincinnati, Ohio.
- Ritter Battery Service, North Sixth St., Lewisburg, Pa.

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247. power pentode for use in the last stage, either alone or in push-pull. It has a greater power sensitivity than any other tube available. Net price, \$1.26.

233. a 2-volt power pentode tube for use as output tube in circuits utilizing the 231 and the 232. Net price, \$1.83.
236. a 6.3-volt general purpose tube of the heater type, suitable for use in automobile receivers. It may be used as detector, oscillator or amplifier. It may be heated with either direct or alternating current. Net price, \$1.23.
236. a 6.3-volt screen grid tube of the heater type which may be used for amplification in receivers utilizing the 237. Net price, \$1.83.

238. a 6.3-volt power pentode tube for use as output tube, singly or in push-pull, in receivers utilizing the 236 and 237. Net price, \$1.93.

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227 @ \$0.88	V-199 @ 1.93	222 @ 3.15
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250 @ 4.20	112A @ 1.05	BH @ 3.10
Kino Lamp @ \$4.75		BA @ 5.20

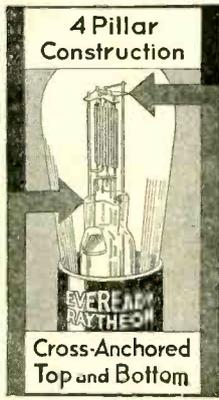
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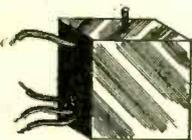
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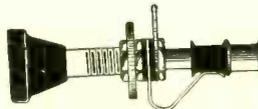
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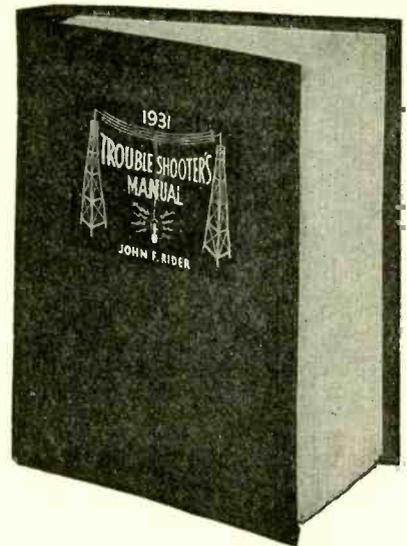
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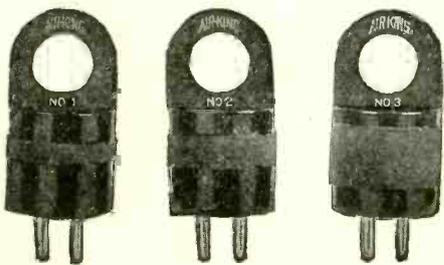
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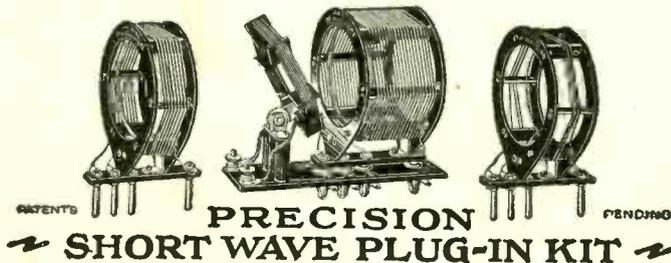
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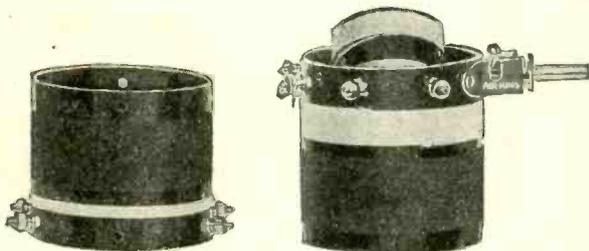
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For .0001 or .00015 mfd. tuning; three plug-in coils with receptacle base as illustrated, with adjustable primary built onto receptacle, 15 to 150 meters. Order PR-AK-1, free with one year's subscription @ \$6.00.

For .00025 or .0002 mfd. tuning: only two coils are required, for 15 to 150 meters. Order PR-AK-2, and get two coils, receptacle and adjustable coil (third inductance) built in. Free with nine months' subscription (39 weeks), at regular rate, \$4.50.

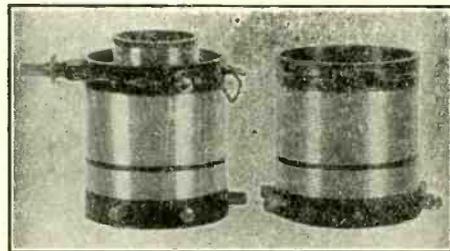
Note—We can supply .00015 mfd. (PR-H-15) or .0002 mfd. (PR-H-20) Hammarlund short-wave midline condenser, swings inside 2-inch diameter, with three months (13 weeks) additional subscription @ regular \$3 rate.

"DIAMOND" PAIR IN STANDARD AND DE LUXE TYPES



The Diamond of the Air is a popular circuit using an antenna coil and a three-circuit tuner. For this circuit the standard Diamond pair of coils consists of two, wound on 3" diameters, except for rotor on smaller form. The standard pair may be obtained for .0005 or .00035 mfd. tuning. Ticker coil has single hole panel mount. For .0005 mfd. order PR-SDP-5, with blueprint, free with a six-month subscription (26 weeks) @ \$3.00. For .00035 mfd. order PR-SDP-35, free with 6-month subscription @ \$3.00.

These coils will give extreme satisfaction and are excellent for the Diamond of the Air, being specified by Herman Bernard, the designer of the circuit.



De luxe Diamond pair, with large primaries center-tapped. For the Diamond use center tap and one extreme of the primary for antenna circuit, RF coil (at right); use full primary on tickler (lowest winding at left). The de luxe pair have silver-plated wire, for loss-reduction, wound on moulded bakelite, with threading, so coils are space-wound to reduce distributed capacity. Three-circuit coil is single-hole panel mount. Additional holes for optional base mounting on both, using brackets (not supplied.) For .0005 mfd. only. (None for .00035 mfd.) Order PR-GWN free with a year's subscription (52 issues) @ \$6.00.

GET THE COMPLETE DATA ON SHORT-WAVE CONVERTERS

Short-wave converters are all the rage. They enable you to tune in short waves on a broadcast receiver of any kind. A serial article by Herman Bernard, on this topic, discussing several models, with full-size picture diagrams, was published in the November 8th, 15th, 22nd, 29th, December 6th, 13th and 20th issues. Send \$2 for 17 weeks' subscription and get these seven issues free. Order PR-SWCS.

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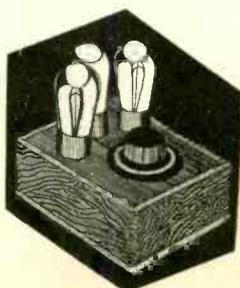
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PARTS FOR A SHORT-WAVE CONVERTER



No matter what type of broadcast receiver you have, you can get short waves by using a short-wave converter built of parts we can supply. The panel is only 5 x 6 1/2 inches. There is only one tuning control. No squeals, howls or body capacity. Two models are available, one for A.C., the other for battery operation. The battery model uses three 227 tubes with heaters in series. Full details supplied with order.

All parts for A.C. model (less filament transformer, less three 227 tubes), order PR-SUP-3A, free with a year's subscription @ \$6.

All parts for the battery model (less three 227 tubes), free with a year's subscription for Radio World @ \$6.00. Order PR-SUP-3B.

A third model (of different appearance than illustrated) enables filament transformer to be built in. All parts, including filament transformer; two wound plug-in coils, 15-200 meters, Hammarlund condenser, (less tubes), order PR-SUP-3FS free with two-year subscription @ \$12.